Installation and Operation Manual

RTU-292
RADIO / TELEPHONE
INTERFACE UNIT

Designed and Manufactured by:

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JPS P/N 5970-600200 **Revision 1.62** **July, 2005**

Warranty

JPS Communications, Inc. warrants its manufactured equipment to be free from defects in materials and workmanship, and to conform to published specifications for a period of 18 months from the date of shipment from the factory or 12 months from installation, whichever occurs first.

JPS warrants its service work performed in connection with this warranty to be free from defects in materials and workmanship for a period of 90 days from the date the work is performed.

If a defect occurs within the warranty period, the buyer shall notify JPS immediately. JPS will repair or replace the equipment at its option, upon return of the equipment; shipping prepaid, to the JPS facility in Raleigh, North Carolina, USA

This warranty does not apply to damage caused by accidents, abuse or improper installation.

NO OTHER WARRANTY, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, SHALL APPLY.

NOTICE

JPS Communications, Inc. reserves the right to make changes to the equipment and specifications without prior notice.

PROPRIETARY STATEMENT

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Glossary

Adaptation	The process whereby the RTU-292 DSP algorithms detect reflected signal information in a connected line and tune the DSP hybrid for a broadband null with minimum reflection.
COR	Carrier Operated Relay - A receiver signal that gives a positive indication that a carrier or signal is being received and that the receiver is unsquelched. Same as COS.
COS	Carrier Operated Squelch - See COR.
CTCSS	Continuous Tone Controlled Squelch System. A squelch system using EIA Standardized sub-audible tones in the 67Hz to 250Hz frequency range. An FM squelch which opens only when the proper sub-audible tone is present.
DIP Switch	Dual In-Line Package Switch (Also "dipswitch")- A multi-unit switch that fits into a standard DIP integrated circuit footprint. It usually contains eight or ten individual switches.
DTMF	Dual Tone Multi Frequency - The standard touch-tone telephone dialing method.
DSP	Digital Signal Processing (or Processor).
EIA	Electronic Industries Association.
Full Duplex	A communications system that can operate in transmit mode and receive mode simultaneously, with different frequencies for transmit and receive. See also Half Duplex and Simplex.
Half Duplex	A communications system that uses different frequencies for transmit and receive operation, but can not transmit and receive at the same time. See also Full Duplex and Simplex.
Hangtime	A system with hangtime will remain in the transmit mode for the duration of the set hangtime beyond the time indicated by any keying inputs. The hangtime prevents transmitter unkey during brief pauses in the transmission.
Key	To key a transmitter means to cause it to transmit.
LED	Light Emitting Diode.
LMR	Land Mobile Radio.
Mute	To quiet or inhibit audio.
PCB	Printed Circuit Board.
PTT	Push-to-Talk. An active PTT signal causes a transmitter to key.
RX	Receiver or Receiving.
Simplex	A communications system that uses the same frequencies for both transmit and receive operation. A simplex system can obviously not transmit and receive simultaneously. See also Full Duplex and Half Duplex.
SNR	Signal-to-Noise Ratio.
Squelch	A means of detecting audio and causing some action when it is present, such as keying a transmitter or unmuting an audio path.
TX	Transmit or Transmitter.
VMR	Voice Modulation Recognition. A type of squelch, which is activated only by spoken words and not by tones, noise, or other audio information.
VOX	Voice Operated Xmit (Transmit). A circuit or algorithm that causes a transmitter to key or some other action when voice or other signal is present. This squelch type is activated by any audio signal, and is not restricted to voice only.

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1 General Information

1.1 SCOPE

This instruction manual provides the information necessary to install, operate, repair and maintain the RTU-292 Radio/Telephone Interface.

1.2 DESCRIPTION

1.2.1 GENERAL

The RTU-292 Radio/Telephone Interface Unit will provide a trouble-free automatic connection between a radio system and telephone or other two-wire line. The unit is suited for use with HF, VHF, UHF or satellite systems and is applicable to full or half-duplex modes. The RTU-292 incorporates a full-featured telephone set and monitor speaker. Flexible switching allows many operating scenarios.

The RTU-292 replaces the JPS Communications RTU-282. The RTU-292 contains all of the features and capabilities of the RTU-282, along with some major improvements. The new DSP used in the RTU-292 allows improved Call Progress Detection. Additional circuitry on the Main Board provides the ability to detect line reversal when a telephone caller hangs up the phone, allowing immediate call termination when used with phone systems that have Reverse Battery Signaling. A new standard feature with the RTU-292 is RS-232 control of the unit. A new optional feature is DTMF Access of the system via radio.

A front panel keypad allows DTMF or Pulse dialing and the built-in handset is pushbutton-selectable for communication with either the telephone or the radio. Since the telephone may place and receive calls, the operator can quickly and easily establish a phone patch connection. When used in the manual mode, the RTU-292 patches a telephone into a radio link by essentially the same method as with a conventional phone patch; the quality of the patch, however is greatly improved. First, a radio-to-radio link is established. Then, using the telephone in the RTU-292, the operator places a phone call to the distant telephone that will be patched into the radio link. Once the telephone-to-telephone link is made, the operator simply pushes a front panel pushbutton. The RTU-292 adapts to the phone line, and the distant phone becomes part of a telephone-to-radio-to-radio communications link. Once this link is established, the operator may communicate with either party using the RTU-292's handset, and may monitor both sides of the conversation with the speaker.

The RTU-292 uses a unique adaptive hybrid implemented with a DSP (Digital Signal Processor) to eliminate conventional VOX and hybrid adjustments for a quick and simple set-up. The unit works by measuring the characteristics of the telephone line. A short burst of white noise is placed on the telephone line. During this burst, the adaptive hybrid in the unit measures the signal reflected from the phone line and adapts the RTU-292 to the impedance of the phone line, minimizing the reflected signal. This achieves a broadband hybrid balance on the reactive phone line. This is simply not possible with any type of conventional active or passive hybrid. Not only is a deep, broadband null provided, but also the action is completely

automatic. The unit will continuously adapt to changing line conditions, making operation insensitive to line impedance changes.

In the Automated Operations mode, the RTU-292 combines the unique features of its adaptive DSP hybrid with fully unmanned auto-dial/auto-answer capability. In its standard configuration, the unit uses tone prompts to signal the remote user of the operations that must be performed to control the unmanned radio station. The addition of a Voice Prompt Option supplies a large number of spoken prompts to simplify control. The Local Phone Option allows a standard telephone set to be plugged into the rear panel of the RTU-292; this local phone may then be used in place of the unit's keypad and handset.

Input and output levels are internally adjustable to accommodate all types of radio systems. A set-up mode allows the adjustment of the RTU-292 receiver and transmitter signal levels without any external test equipment.

The unit will interface all types of two-wire lines, such as normal dial-up lines, dedicated lines, or twisted-pair field wire. Although the output impedance is fixed at 600 Ohms, the adaptive hybrid in the unit will give excellent hybrid balance regardless of the impedance of the line connected to the unit.

The unit operates from 115 or 230 VAC, 47 to 63 Hz, or from +12 or +24/+28 VDC nominal; the +12VDC range extends from +11 to +15 VDC, while the +24/+28 VDC range extends from +22 to +30 VDC. It is packaged in a rugged enclosure measuring 3.5"H x 19"W x 12"D. All inputs and outputs, including those for power, are filtered or protected as appropriate to enable the RTU-292 to meet the requirements of FCC Part 15 rules for a Class A Digital Device.

1.3 ASSEMBLIES

The standard RTU-292 contains five PC board assemblies; the main board (with plug-on adaptive hybrid DSP board), three front panel switch PC board assemblies, and the Options Interface Board, which is mounted in the Options Tray where other option boards may be installed. Mounted on the front panel along with the switchboards are a speaker, control potentiometers, phone jack and handset jack. The various I/O connectors and the DC power input connector are accessible via the rear panel.

1.3.1 MAIN BOARD

The main board has six general sections of circuitry: the Telephone Interface section, Handset/Speaker Interface section, Radio Interface section, DSP section, CPU section, and Power Supply section. These are described briefly in the following paragraphs. Refer to the RTU-292 block diagram along with the text. (The power supply and DSP sections are not shown in the block diagram, refer to Section 4 for more details.)

1.3.1.1 Telephone Interface

The Telephone Interface Section has the amplifiers that drive and receive audio from the phone line. This section also contains the DSP hybrid (which is detailed in Section 4 of this manual), interfaced with the keypad. A tone ringer generates a warble audio tone when ring voltage is received.

1.3.1.2 Handset/Speaker Interface

The Handset/Speaker Interface Section contains the speaker pre-amp and driver, the headphone pre-amp and driver. Audio gates controlled by the front panel switches route the audio to the speaker and handset microphone preamplifier and ALC (Automatic Level Control) circuit.

1.3.1.3 Radio Interface

The Radio Interface Section consists of operational amplifier circuits that handle the audio interfaces between the RTU-292 and the radio. The amplifiers provide gain adjustability to accommodate various input and output levels, and also provide impedance transformation and output drive capability. Audio gates controlled by the front panel switches and the CPU route the audio as desired by the operator.

1.3.1.4 DSP Module

The plug-in Digital Signal Processor (DSP) module is the heart of the unit, as the adaptive hybrid is implemented with the DSP. From a hardware standpoint, the DSP section consists of a DSP chip interfaced with dual analog interface ICs, static RAM for audio storage and delay, and a program flash memory IC.

From a software standpoint, the following functions are implemented in software in the DSP section: the adaptive hybrid, the VOX, an audio peak detector, the noise generator for measuring the telephone line characteristics, an audio delay and the transmit setup tone generator.

1.3.1.5 CPU Section

This section contains the microprocessor and program software that controls all operations of the RTU-292. Various I/O devices read external inputs and the front panel controls. The inputs are processed and audio gates, front panel LEDs, audio prompts, etc., are controlled accordingly.

1.3.1.6 Power Supply Section

The power supply in the RTU-292 is a quiet and reliable passive regulator type. It furnishes regulated voltages of +12V, -12V, +5V and -5V to the unit.

1.3.2 FRONT PANEL SWITCH ASSEMBLIES

There are three separate front panel switch assemblies that contain the pushbutton switches and LED indicators for the RTU-292. Each of these assemblies contains a different complement of components as required by its function. Signals from the switches are read by the CPU circuitry on the main board. The processor then routes audio signals and lights the front panel LEDs according to the pushbutton commands.

1.3.3 OPTIONS INTERFACE BOARD

This board, located on the Options Tray above the main board, contains the connectors used to interface the main board to the various option boards that may be assembled to the Options Tray.

Table 1-1 **Equipment and Accessories Supplied**		
Qty	***Part Number***	***Item***
1	5970-600000	RTU-292 Standard
1	5970-600200	Operation & Maintenance Manual
1	5970-600150	Accessory Kit
Accessory Kit Consists of:		
Qty	***Part Number***	***Item***
1	0150-200000	Handset, PTT, black
1	0313-037770	Cable, misc., power w/3-wire connector
1	0313-060000	Cord, coiled, black (for handset)
2	0360-009000	Connector, cable, DB-9 receptacle
2	0650-005100	Fuse, 3AG, 1/2A, slow blow
2	0650-010100	Fuse, 3AG, 1A, slow blow
2	0827-000001	HW, clamp, cable, for DB-9 connector
1	0827-102401	HW, Telephone Hanger; may be attached to front panel (holes provided)
9	0833-063205	HW, screw, flat head, 6-32 x 5/16", 100 degrees, (spares for top cover mounting)
5	0837-103200	HW, screw, truss head, #10-32x3/8, for mounting unit front panel to rack (includes one spare)
5	0848-100001	HW, washer, flat, nylon (#10 by ½" diameter by 1/16" thick), for mounting unit front panel to rack (includes one spare)

1.3.4 OPTIONS

RTU-292 options include the: The Voice Prompt Option, which gives verbal prompts to the user as an aid in all aspects of unit operation; The Local Phone Option, which allows a DTMF telephone set to be plugged into the unit, allowing control and access from the phone set; and the VMM-100 module, used to add VMR (Voice Modulation Recognition) and DSP noise reduction capability. Among the Software Options are the Squelch Break Access Option, which allows a radio to contact the system via series of squelch breaks and the DTMF Access Option, which allows a radio user to contact the system via a DTMF keypad. Other Software Options include Call Logging and Remote Control of an URC-200 radio. Various spares kits are also available. The STU-III option allows a STU-III phone to be connected to the RTU-292. This allows an encrypted STU-III conversation to be decrypted at the RTU-292. The decrypted signal is patched into the connected radio system.

Table 1-2 **Optional Equipment - Not Supplied**

Item	*JPS P/N*	*Description*
Depot Spares Kit	5970-691000	Spares for 3 to 5 RTU-292s
Spare PC Board Kit	5970-692000	Spare Boards for 1 unit
Spare Parts Kit	5970-693000	Spares for one RTU-292
Local Phone Option	5930-596000	Allows remote operation of the RTU-292 through the use of a standard telephone set connected directly to the RTU-292 Local Phone port. (Telephone set and cable not supplied.)
DTMF Telephone Set	5930-599000	Telephone set for use with the Local Phone Option
Voice Prompt Option	5930-595000	Standard Version (English, female voice)
VMM-100 Option	5930-591100	Provides DSP Voice Modulation Recognition squelch and/or DSP Noise Reduction to the radio RX input.
STU-III Option	5960-796000	Allows connection to a STU-III phone
Rack Slides Kit	5930-594000	1 set slides and hardware to rack-mount one RTU-292.
Software Options		
Call Logging S/W Option	5970-791500	Provides record of calls via RS-232 interface.
Radio Control Option	5970-795000	Provides remote control of URC-200 radio via RS-232 int.
Squelch Break Access	5970-791300	Allows radio connection via series of squelch breaks
DTMF Access Option	5970-799000	Allows radio connection via DTMF keypad.

Table 1-3 **RTU-292 SPECIFICATIONS**	
TELEPHONE LINE INTERFACE (J2, Male DB-9 Connector)	
Output & Input Levels to Phone Line	Nominally -12 dBm. (Adjustable -21 to 0 dBm in 3 dB steps).
Frequency Response	±2 dB, 300 to 3200 Hz.
Output Impedance to Phone Line	600 Ohm .
VOX Sensitivity	16 ±2 dB Below Phone Line Input Level Setting. (-25 dBm @ -9 dBm Level Setting, for example)
VOX Hang Time	0.6 Second or 2.0 Seconds, (Internally Settable).
Hybrid Balance/Adaptation Speed (into 600 Ohm)	-30 dB over 300 to 3200 Hz BW within 1.25 Sec.; measured with white noise source.
Ultimate Hybrid Balance (into 600 Ohm)	-50 dB typical over 300 to 3200 Hz BW; measured with a single tone.
Hybrid Impedance Matching Capability	0 to 10k Ohm Complex Impedance.
Phone Line Connections	RJ11C Connector (J1) and screw terminals on rear panel term block.
RADIO INTERFACE (J1, Male DB-9 Connector)	
Input Impedance	Balanced or Unbalanced 600 Ohm or Unbalanced 47K Ohm.
Input Level	-40 to +10 dBm, Internally Adjustable.
Output Impedance	600 Ohm balanced.
Output Level	-40 to +10 dBm, Internally Adjustable
Frequency Response	300 to 3200 Hz ± 2 dB.
Key Relay Output	Low Level Relay Contacts, 60VA max., Switching Speed: 5 msec.
TELEPHONE	
Handset (RJ12C Jack)	Electret microphone, dynamic receiver.
Dialing Modes	DTMF, Pulse at 10 pps
Pulse Dial Make/Break Ratio	40/60.
Dialing Keypad	3x4, Standard Telephone Layout.
GENERAL	
Microphone Interface	ALC (Automatic Level Control) with 30 dB dynamic range.
Headphone Interface	Drives high, medium, or low impedance headphones.
Phones Jack (monaural)	Delivers NLT 10mW into 600-Ohm headphones.
Speaker Driver Power	4W min @ 10% Distortion.
Internal Speaker	3 inch square, 3.2 Ohms.
Indicators	Peak Level, Keyed, and Indicator for each pushbutton.
Front Panel Controls	Power Switch, Dialing Keypad, Speaker and Handset Volume Controls, Pushbuttons: Tel Line/Phone, Tel Line/Radio, Off, Handset/Phone, Handset/Radio, Speaker/Phone, Speaker/Radio, Tel VOX, Manual Key, Auto Answer, Audible Ring.
AC Input Power	115 or 230 VAC +/- 15%, 47-63 Hz, 20 VA typical, 50 VA max.
DC Input Power	+11 to +15VDC or +22 to +30VDC, 1 A Maximum.
Size	3.5"H x 19"W x 10"D (8.9 x 48.3 x 25.4 cm)
Weight	12 lbs. (5.5 kg).
ENVIRONMENTAL	
Operating Temperature	-20^0 C to $+55^0$ C.
Storage Temperature	-40^0 C to $+85^0$ C.
Humidity	Up to 95% @ 55^0 C.
Shock	MIL-STD-810D, method 516.3 procedure VI.
Vibration	MIL STD 810D, method 514.3 Category I.

2 Installation

2.1 GENERAL

This section provides the instructions for unpacking, inspection, installation and set-up. Also included are directions for reshipment of damaged parts or equipment.

2.2 UNPACKING AND INSPECTION

After unpacking the unit, retain the carton and packing materials until the contents have been inspected and checked against the packing list. If there is a shortage or any evidence of damage, do not attempt to use the equipment. Contact the carrier and file a shipment damage claim. A full report of the damage should also be reported to the JPS Customer Service Department. The following information should be included in the report:

1. Order Number
2. Equipment Model and Serial Numbers
3. Shipping Agency
4. Date(s) of Shipment

The JPS Customer Service Department can be reached by phone at (919) 790-1011, by fax at (919) 790-1456. Upon receipt of this information, JPS will arrange for repair or replacement of the equipment.

2.3 RESHIPMENT OF EQUIPMENT

If it is necessary to return the equipment to the manufacturer, a Returned Material Authorization (RMA) number must first be obtained from JPS. This number must be noted on the outside of the packing carton and on all accompanying documents. When packing the unit for reshipment, it is best to use the original packaging for the unit; if this is not possible, special attention should be given to providing adequate packing material around connectors and other protrusions, such as front panel controls. Rigid cardboard should be placed at the corners of the unit to protect against corner damage during shipment. Failure to protect the corners of the front panel causes the most common type of shipping damage experienced on returned equipment.

Shipment should be made prepaid consigned to:

JPS Communications, Inc.
Customer Service Department
5720M Capital Blvd.
Raleigh, North Carolina 27616
USA

Plainly mark with indelible ink all mailing documents as follows:

U.S. GOODS RETURNED FOR REPAIR

Mark all sides of the package:

FRAGILE - ELECTRONIC EQUIPMENT

Inspect the package prior to shipment to be sure it is properly marked and securely wrapped.

2.4 INSTALLATION OVERVIEW

Follow these four steps to properly install the RTU-292:

1. Provide mechanical mounting for the unit. (Rack slides or shelves are required for 19" rack mounting)
2. Provide the proper primary power for the unit.
3. Interconnect the unit with the radio and system as appropriate.
4. Check Section 2.8 to ensure that the unit is adjusted and configured as desired.

The RTU-292 is then ready to begin normal operation.

2.5 INSTALLATION CONSIDERATIONS

Careful attention to the following installation suggestions should result in the best unit/system performance. Figure 2.1 provides overall unit dimensions.

The RTU-292 must be installed in a structure that provides both protection from the weather and assurance of ambient temperatures between -20 and +55 degrees C. Since the unit is neither splashproof nor corrosion resistant, it must be protected from exposure to salt spray. When the unit is mounted in a cabinet with other heat-generating equipment, the use of a rack blower is suggested to keep the cabinet interior temperature rise to a minimum.

NOTE

Before actually installing the unit, read Section 2.8 to determine if any internal configuration options must be changed that would necessitate removal of the unit's top cover.

The RTU-292 Radio/Telephone Interface is designed to be mounted in a standard EIA 19" wide rack by means of chassis slides (may be ordered from JPS) or on an L-bracket shelf. The unit weighs too much to be installed in a rack supported only by the front panel ears. Screws are provided in the accessory kit for securing the unit to the rack via the front panel.

Included in the Accessory Kit is a handset hanger; this hanger may be assembled to the unit's front panel. Use the screws located below the logo and unit name. The hanger may also be assembled to the side of an equipment rack or elsewhere as desired.

2.5.1 FCC PART 68 REGULATIONS

The RTU-292 has been designed to comply with FCC Part 68 regulations regarding equipment connected to telephone lines, but is not officially certified. If tested compliance to FCC Part 68 is required, external equipment can be installed between the RTU-292 and the telephone line to provide compliance.

Table 2-1 **RTU-292 Factory Default Settings**

This table describes the settings of all RTU-292 internal adjustments and switch positions as set when the unit is shipped.

Feature / Function	Adjustment	Default Setting
Telephone Send and Receive Levels	SW2-1, 2,3	-9 dBm
Dial Mode	SW1-4	DTMF
VOX Sensitivity	SW2-4, 5	Medium
VOX Hangtime	SW2-6	Long (2 second hangtime)
Full/Half Duplex	SW2-8	Half Duplex
RX Audio Interface	JP1, JP2	600 Ohms, Balanced
TX Audio Interface	JP3	600 Ohms, Balanced
Internal Audio Potentiometers	R156, Ring Volume	Midrange
	R116, RX Lvl Adj	0 dBm input
	R133, TX Lvl Adj	0 dBm output
Serial Port Baud Rate	SW1-1, 2	9600 Baud
Spare	SW1-3	Off
Password Protection	SW1-5	Disabled
Voice Prompts Enable	SW1-6	Enabled if Option Installed
Local Phone Enable	SW1-7	Enabled if Option Installed
Local Phone Ring Through	SW1-8	Enabled if Option Installed
DC Input Power Selection (+12 or +24/28 VDC)	Internal Switch S6	+24/+28 VDC (nominal) (+22 to +30 VDC)

2.6 POWER REQUIREMENTS

The RTU-292 is designed to operate from 115V or 230V, 47 to 63 Hz, single phase AC power source. The unit will meet all of its specifications over a voltage range of ±15% from nominal. Power consumption is 20 VA typical, 50 VA maximum.

Alternatively, the unit may be operated from a (nominal) +12, +24, or +28 VDC supply. At the +12VDC setting, the unit will operate from +11 to +15VDC, and at the +24/+28 VDC setting, the unit will operate from +22 to +30 VDC. Slide switch S6 on the Main Board selects either +12 or +24/+28 VDC.

2.7 INPUT POWER SELECTION

2.7.1 LINE VOLTAGE SELECTION

CAUTION

To prevent damage to the unit, check the power line voltage selection before applying power. Also be certain that the unit is connected to a grounded outlet.

As shipped from the factory, the RTU-292 is normally set for the correct line voltage in the area where it will be installed, but the voltage selection should be checked before initial operation. The number visible through the window in the line power module (located on the rear panel) indicates the nominal line voltage range in the following manner:

100 or 120 position: nominal 115V operation
220 or 240 position: nominal 230V operation

(The number will be easier to see if the clear fuse cover is slid to the left with the line cord removed.) To change the voltage selection, remove the line power cord and slide the clear plastic fuse cover to the left, exposing the fuse. Pull the small handle marked "Fuse Pull", rotate the handle to the left and remove the fuse. With the "Fuse Pull" handle to the left, pull the voltage selector card from its slot and replace it with the desired operating voltage appearing at the top left side. Rotate the "Fuse Pull" handle back to the right and snap the fuse back into the metal clips.

The fuse should be either:

115V operation: 1 A time-delay fuse

230V operation: 1/2 A time-delay fuse

To replace a blown fuse, follow the same general procedure, except that the voltage selector card need not be removed.

2.7.2 DC INPUT POWER SELECTION

Internal slide switch S6 is used to configure the RTU-292 to accept DC power from a (nominal) +12 or +24/+28 VDC source. The +12/+28 VDC position will work with +24 VDC (nominal

and +28 VDC (nominal) supplies. The unit will automatically switch over to the use of the DC input when the AC source drops too low or is not available. Slide switch S6 on the Main Board is used to select either +12 or +24/+28 VDC operation. S1 is located near the left front edge of the Main Board; the +12V and +24/+28V switch positions are clearly marked on the board. The RTU-292 is set in the factory to the +24/+28 VDC position.

2.8 CONFIGURING THE RTU-292

The RTU-292 factory default settings are listed in Table 2-1. The factory set-up will be correct for most installations; explanations of each feature selection method or other adjustment are provided for systems requiring different set-ups. If any setting must be changed, refer to Figure 2-3, "Internal Adjustments Locations". Remove the top cover of the unit by removing the Phillips-head screws around its edges.

NOTE:

Many of the RTU-292's operating parameters are set by internal eight-position dipswitches SW1 and SW2. These switches are read by the RTU-292 microprocessor only when the unit power is turned on. To change any dipswitch controlled parameter, turn off the RTU-292, change the switch setting(s), and then turn the unit power back on.

2.8.1 PROGRAMMING MODE SETUP PARAMETERS

Some of the RTU-292 setup options are selected by entering DTMF commands by a connected telephone or Local Phone Option telephone set. Since these parameters are set after a connection is made, they are detailed in section 3. See Table 3-2, "Programming Mode DTMF Commands".

2.8.2 SETTING TELEPHONE SEND AND RECEIVE LEVELS

The levels of the audio signal that are sent into (Send) and received from (Receive) the telephone line are adjustable via SW2 switches 1 through 3 on the RTU-292 Main Board. The levels are adjustable from -21 dBm (600 Ohm) to 0 dBm in 3 dB steps. The dipswitches simultaneously set the Send and Receive levels.

Table 2-2 **Recommended Phone Line Settings**	
Type of System	**Send & Receive Levels**
Dial-Up lines in a U.S. Domestic phone system	-9 dBm
Dial-Up lines in most non-U.S. telephone systems	-9 dBm
PBX Systems	-12 dBm
Field Wire not connected to a telephone network	-6 dBm

When using the RTU-292 in a domestic U.S. dial-up telephone network, the MAXIMUM level allowed into a telephone line at the subscriber end is -9 dBm. Putting more level into the line than this will NOT increase performance, but will result in distortion, crosstalk into other circuits and the telephone company may disconnect the call. When operating into a PBX system, the level should be set at -12 dBm. Higher levels than these may be only used into field wire or dedicated or private lines, which are KNOWN to accommodate higher levels.

The send and receive levels are set by SW2-1, 2,3 as follows:

Factory default settings are indicated by an asterisk *

Table 2-3 **Telephone Send/Receive Levels**			
SW2-1	**SW2-2**	**SW2-3**	**Level**
Off	Off	Off	O dBm
On	Off	Off	-3 dBm
Off	On	Off	-6 dBm
On	On	Off	-9 dBm *
Off	Off	On	-12 dBm
On	Off	On	-15 dBm
Off	On	On	-18 dBm
On	On	On	-21 dBm

2.8.3 VOX HANGTIME

The RTU-292 VOX circuitry holds the radio in the keyed state for a short time after the telephone audio signal is no longer detected. This delay, called hangtime, ensures that the VOX is not de-activated between syllables or during short pauses in speech. The standard VOX hangtime duration is 2.0 seconds. Dipswitch SW2-6 allows the setting of 0.6 seconds hangtime if required. The factory default setting, SW2-6 On, sets the VOX hangtime to the longer 2.0 second setting, and SW2-6 Off sets it to 0.6 seconds.

Table 2-4 ***VOX Hangtime***

SW2-6	Key Tone Detection
Off	Short 0.6 seconds
On	Long 2 seconds *

2.8.4 VOX SENSITIVITY

The RTU-292 VOX circuitry has four sensitivity levels; minimum, low, medium (factory setting), and maximum. A higher setting will be more able to detect weak or noisy voice signals, but will be more likely to false on ambient noise entering the telephone handset. A lower setting will do the opposite. SW2-4 and SW2-5 control the unit's VOX Sensitivity levels:

Table 2-5 ***VOX Sensitivity***

SW2-4	SW2-5	VOX Sensitivity
Off	Off	Min
On	Off	Low
Off	On	Med *
On	On	Max

2.8.5 BALANCED/UNBALANCED RADIO INTERFACE

Internal jumper fields JP1 and JP3 set the unit for either a Balanced or Unbalanced audio interface to the radio or other four-wire device connected to the J2 RADIO Connector. Set the jumper plug across JP1 pins 2&3 for balanced input and across pins 1&2 for an unbalanced Receive Audio input. Similarly, set the jumper plug across JP3 pins 2&3 for balanced TX Audio output and across pins 1&2 for an unbalanced output. The factory setting for both input and output is balanced.

2.8.6 RX LINE INPUT IMPEDANCE

The factory setting for the Receive Line input impedance is 600 Ohms, but if a high input impedance for bridging is needed, the impedance may be set to approximately 47k Ohm. To set to high impedance, move the jumper plug at JP2 from pins 1&2 (low, 600 ohms) to pins 2&3 (high, 47k ohms).

2.8.7 DIAL MODE

The dialing mode of the RTU-292's internal telephone is set by internal dipswitch SW1-4. The dial mode choices are DTMF and 10pps Pulse. DTMF should always be used if the RTU-292 is interfaced with a touch-tone (DTMF) capable telephone line. Note that, even when set for pulse dialing, the RTU-292 can still send DTMF tones onto the phone line to control automated systems such as voice mail. After a call has been placed, the user may press either the star (*) or pound (#) key. The RTU-292 will then produce DTMF tones in response to keypad presses from either the front panel keypad or a connected local phone set. Once the current call is terminated, the RTU-292 will revert to the pulse dialing mode.

Table 2-6 ***Dial Mode***

SW1-4	Dial Mode Selection
Off	DTMF *
On	Pulse (10 pps)

2.8.8 TELEPHONE RING VOLUME

The telephone ringer volume may be set to a comfortable level with internal adjustment R156. If the ambient noise level in the RTU-292's location makes it necessary to change the ringer volume, rotate R156 clockwise to increase the volume and counterclockwise to decrease it.

2.8.9 FULL/HALF DUPLEX RADIO

In full duplex operation, the RTU-292 will simultaneously send transmit audio to the radio and take in its receive audio. In half duplex operation, the radio receive audio is muted while the radio is keyed. This prevents a radio sidetone audio feedback loop in radios with sidetone audio. This feedback loop hampers RTU-292 VOX operation. (Sidetone audio is transmit audio that is internally routed back into the receive audio when the radio is keyed, allowing the radio operator to hear his transmission.)

The Full/Half Duplex selection is set by dipswitch SW2-8. The factory setting is SW2-8 On, for Half Duplex, preventing the feedback loop. To set to Full Duplex operation (receive audio not muted during transmit), set SW2-8 to Off. For Simplex Systems, use the Half Duplex setting.

Table 2-7 **Full/Half Duplex**	
SW2-8	**Full/Half Duplex**
Off	Full Duplex
On	Half Duplex *

2.8.10 SERIAL PORT BAUD RATE

Internal dipswitches SW1-1 and SW1-2 on the Main board configure the RS-232 baud rate of the unit's serial port as shown in the table below. The factory setting is 9600 Baud.

Table 2-8 **Baud Rate**		
SW1-1	**SW1-2**	**Baud Rate**
Off	Off	300
On	Off	1200
Off	On	4800
On	On	9600 *

2.8.11 RADIO CONTROL MODE

Dipswitch SW1-3 enables the RTU-292 to be put into the Radio Control Mode via one of its DTMF commands. In this mode the RTU-292 can be used to relay radio control commands via its RS-232 port to a companion Motorola URC-200 radio. The factory default disables this mode, with SW1-3 set to OFF. See also Tables 3-1 and 3-3.

Table 2-9 Radio Control Mode	
SW1-3	**Radio Control**
Off	Disabled *
On	Enabled

2.8.12 PASSWORD PROTECTION

Dipswitch SW1-5 enables or disables the RTU-292's password protection feature. Password protection prevents unauthorized access to the system from the PSTN line when the RTU-292 is in the Automated Operation Mode. (See section 3.7 for a full explanation of Automated Mode Operation and the use of the Password Protection Feature). The factory setting is disabled, SW1-5 Off. To enable the password protection feature, turn SW1-5 On. The factory default password is "1 2 3 4", but may be changed to any number up to 10 digits long. See Table 3-2.

Table 2-10 **Password Protection**

SW1-5	Passwords
Off	Disabled *
On	Enabled

2.8.13 VOICE PROMPTS

Dipswitch SW1-6 enables or disables the use of Voice Prompts in the RTU-292. This feature should be enabled only if the Voice Prompt Option is installed. See section 3.7 for an explanation of the Voice Prompt feature operation, and section 7.2 for field installation. The factory default setting: disabled if the Voice Prompt Option is not installed and enabled if it is.

Table 2-11 **Voice Prompts Enable**

SW1-6	Voice Prompts
Off	Disabled
On	Enabled

2.8.14 LOCAL PHONE / LOCAL PHONE RING-THROUGH

Dipswitch SW1-7 enables or disables the RTU-292 Local Phone Option. This feature should be enabled only if the Local Phone Option is installed. The factory setting is: Disabled (SW1-7 Off) if the Local Phone Option is not installed and enabled (SW1-7 On) if it is. See section 3.7 for an explanation of Local Phone Option operation, and section 7.3 for field installation instructions.

SW1-8 enables the Local Phone Ring-Through feature. This causes the local phone to ring whenever a call is received by the RTU-292 via the PSTN input. When disabled, the local phone may still be used to send and receive calls, but will not ring when a call is received. Set SW1-8 to On to enable Local Phone Ring-Through, and Off to disable this feature. This switch should always be set to Off (disabled) when the Local Phone Option is not installed. The factory setting is On (enabled) when the Local Phone Option is installed and Off (disabled) otherwise.

Table 2-12 **Local Phone Enable**	
SW1-7	**Local Phone**
Off	Disabled
On	Enabled

Table 2-13 **Local Phone Ringthrough**	
SW1-8	**Ringthrough**
Off	Disabled *
On	Enabled

2.8.15 TRANSMIT LEVEL SET-UP MODE

Dipswitch SW2-7 is used by the factory to enable a special set-up mode. See section 2.10 for instructions. This switch must remain Off (Normal Mode) for standard operation.

Table 2-14 **TX Level Set-up Mode**	
SW2-7	**Set-up Mode**
Off	Disabled *
On	Enabled

2.8.16 MISCELLANEOUS JUMPERS

The following jumpers are installed in the factory as required. This explanation is provided in case they are accidentally removed and must be replaced.

Security Option Jumpers on J5. Unless a Security Option Interface Cable is plugged into J5 on the Main Board, jumper plugs must be installed at J5 pins 4&5 and pins 7&8.

Option Jumpers on J10. If the Option tray is not installed, a jumper must be placed at pins 13&14 of J10. This jumper allows normal operation of the unit when the Options Tray and the Options Interface Board are not installed.

2.9 INTERCONNECT INFORMATION

Interconnect cables should be shielded for best performance. Figure 2.6, Interface Details, gives simplified interconnect information about the unit.

2.9.1 TELEPHONE CONNECTION

Connect the telephone line to the PHONE J1 RJ11C standard modular connector. The unit will work with either an AC or DC telephone line. Telephone line polarity is not important. Note that the phone connections are repeated at the terminal block on the rear panel for convenience. Only one phone line may be connected; do not use J1 and the telephone connections on the terminal block simultaneously.

Table 2-15 ***J1 - TEL LINE (RJ-11C)***

Pin	Function
1	Not used
2	No Connection
3	Telephone Line Connection A
4	Telephone Line Connection B
5	No Connection
6	Not Used

2.9.2 RADIO CONNECTION

Connect the radio system to the RADIO J2 connector. The TX output and RX input are designed to interface with 600 Ohm line connections at the radio, but the RTU-292 audio interface is extremely flexible and can accommodate a wide variety of sources and loads. By making different connections, the inputs and outputs may be configured for balanced or unbalanced lines. The balanced configuration is the factory default and should be used if possible, because it is the most noise-immune. To change to the receive audio to unbalanced, single-ended input, connect the receive audio to RXA only and change jumper JP1 on the Main Board to UNBAL. To change to the transmit audio to unbalanced, single-ended output, connect the transmit audio to TXA only and change jumper JP3 on the Main Board to UNBAL. Figures 2-5 and 2-6 details the various audio interface options. P1 pin 4, the External Signal input, is used as the Squelch Break input. Key Out A and Key Out B are normally floating, but pull to ground whenever the RTU-292 wants to key the associated transmitter. The Remote Key Input may be pulled low to force the RTU-292 to key the associated transmitter.

Table 2-16 P1-RADIO (DB-9 Male)	
Pin	**Function**
1	Balanced Receive Audio Input B
2	Chassis Ground
3	Transmit Audio Output A
4	External Signal Input
5	/Key Output A (Relay Closure to Ground)
6	Receive Audio Input A
7	Transmit Audio Output B
8	/Remote Key Input
9	/Key Output B (Relay Closure to Ground)

2.9.3 HANDSET CONNECTOR

The handset supplied with the RTU-292 is plugged into front panel jack J7.

Table 2-17 J7 - HANDSET (RJ12C Jack)	
Pin	**Function**
1	+5V Source
2	Ground
3	Ground
4	Earpiece Audio
5	Mic In
6	PTT Switch

2.9.4 TERMINAL BLOCK

The terminal block on the rear panel is supplied for convenience when interfacing the RTU-292 to a communications system. The terminal block connections are in parallel with the I/O terminals of the same name found on different connectors. If the telephone line connections at Pin 1 and 2 of the terminal block are used to connect to PSTN line, then the TEL LINE connector, J1, should not be used.

Table 2-18 ***Terminal Block (6 Position)***

Pin	Function
1	Telephone Line Ring
2	Telephone Line Tip
3	/Key Out
4	/Key In
5	Ground
6	Spare (See Note Below)

NOTE

In the RTU-282, Pin 6 of the terminal block was the /Squelch In input (also called "External Signal In" for use with the Squelch Break feature. In the RTU-292, this input has been moved to a more appropriate location, pin 4 of the P1 Radio Connector. When retrofitting an RTU-292 into an existing RTU-282 installation, it's possible to maintain the existing interface wiring, with the /Squelch line connected to pin 6 of the Terminal Block. For this to work, an internal jumper must be added from E1 to E11 on the main PCB. E1 is located just below J12, the connector that interfaces the terminal block to the main PCB. E11 is at the back of the PCB, beneath the terminal block connections.

2.9.5 RS-232 CONNECTION

Use P2 on the rear panel to connect to the RTU-292 RS-232 interface. RS-232 control is fully explained in section 5.

Table 2-19 **P2 – RS-232 Connector (DB-9 Male)**

Pin	Function
1	No Connection
2	RS-232 RX Input
3	RS-232 TX Output
4	Reserved- Do not connect
5	Ground
6	Reserved- Do not connect
7	No Connection
8	No Connection
9	No Connection

2.10 AUDIO LEVEL SETUP AND ADJUSTMENTS

For proper operation of the RTU-292, the radio transmit and receive levels must be properly set. The radio receiver level into the RTU-292 is of particular importance, because excessive level here can cause telephone line overloading, distortion, VOX falsing and poor hybrid operation. It is also important that the output level to the transmitter be set so that excessive compression does not occur in transmitters with a compressor.

2.10.1 SETTING THE TRANSMIT LEVEL

There are two ways (detailed below) to set the transmit level: First apply TX audio by one of two methods: (A) Use a 1 kHz test tone supplied by the RTU-292 when in the Transmit Level Set-Up Mode, or (B) simply speak into the telephone line to supply typical audio to the RTU-292. Next, rotate the internal TX Level Adjust R133 so that the transmitter is just fully modulated. Either method will set the correct transmit level in the majority of cases. The radio may also have a TX audio level setting procedure in its installation manual. If so, use the radio's procedure in conjunction with the directions below.

2.10.1.1

(A) Set-Up Mode. Enter the Set-Up Mode by turning off the unit, setting dipswitch SW2-7 to ON. Turn unit power back on. In this mode, the RTU-292 DSP module generates a test tone at the same amplitude as voice peaks received on a telephone line, and applies this tone to the RTU-292 transmitter output. While in the Set-Up Mode, key the transmitter by pushing the KEY pushbutton or by other means. If using (B) Telephone Line Method; simply press the TEL-LINE-RADIO button and speak into the phone.

2.10.1.2

Adjust TX Level Adjust so that the transmitter is just fully modulated. If the transmitter is AM or SSB, use its output power meter (if available) to determine the amount of modulation. Do this by advancing R133 clockwise just until the power meter stops rising. This will produce maximum modulation without activating the radio's compressor. When using an FM transmitter, a deviation meter may be necessary to determine the amount of modulation.

NOTE

The RF Power meters on most SSB transmitters do not respond accurately to voice peaks, so a low RF meter indication on actual voice from the RTU-292 may make the transmitter appear to be under modulated. If the TX Level Adjust is increased in an attempt to compensate for a low meter indication, level compression will likely result, which will degrade system performance. If there is any doubt about the amount of modulation being obtained, monitor the RF output with an oscilloscope to observe the true conditions.

NOTE

Avoid excessive level into the transmitter. While most modern transmitters have modulation limiters which will not allow them to over-modulate, excessive level into the transmitter will cause level compression of the signal which effectively degrades the hybrid null provided by the RTU-292. This is particularly important with a full duplex system, which may oscillate if too much level compression is used. For best results, adjust the TX Level Adjust so that the transmitter is just fully modulated by the test tone or actual phone line audio.

NOTE

If the Transmit Level Set-up Mode was used, be sure to take the unit out of this mode after set-up is complete by turning off the main power, switching SW2-7 back to OFF, and turning the power back on.

2.10.2 SETTING THE RECEIVE LEVEL

The audio level into the RTU-292 from the radio receiver is set by the internal RX Level adjustment potentiometer, R116. The PEAK LED responds to the receiver audio coming from the radio and is provided as a guide to setting this level (there are two peak LEDs, CR24 on the Main Board as well as the front panel PEAK LED). The TEL LINE/RADIO button must be ON for the PEAK LED to function. The level is correctly set when the PEAK LED flashes occasionally (once per second to once every few seconds) in response to voice peaks in the incoming audio. If the indicator flashes continuously, the level is too high and must be reduced.

To set the level, tune the receiver to a station with a strong signal that will provide maximum audio into the RTU-292. Turn the RX Level Adjust control clockwise (to increase the level) or counterclockwise (to decrease the level) as necessary until the PEAK indicator flashes

occasionally on voice peaks. Note that the PEAK indicator responds only to incoming radio audio, not telephone audio.

The range of the RX Level Adjust control is about -40 dBm to +10 dBm. If the level from the radio is outside this range, the correct level cannot be set using the RX Level Adjust control alone, and it will be necessary to adjust the audio output at the radio itself until the correct level is obtained.

NOTE

The proper operation and excellent performance of the RTU-292 will not be obtained if the audio level from the receiver into the RTU-292 is not set correctly. Excessive audio will overload the telephone line and equipment, causing distortion, VOX falsing and poor hybrid operation. In addition, the telephone company may cut off a call in progress, which contains audio high enough to bleed over into other circuits.

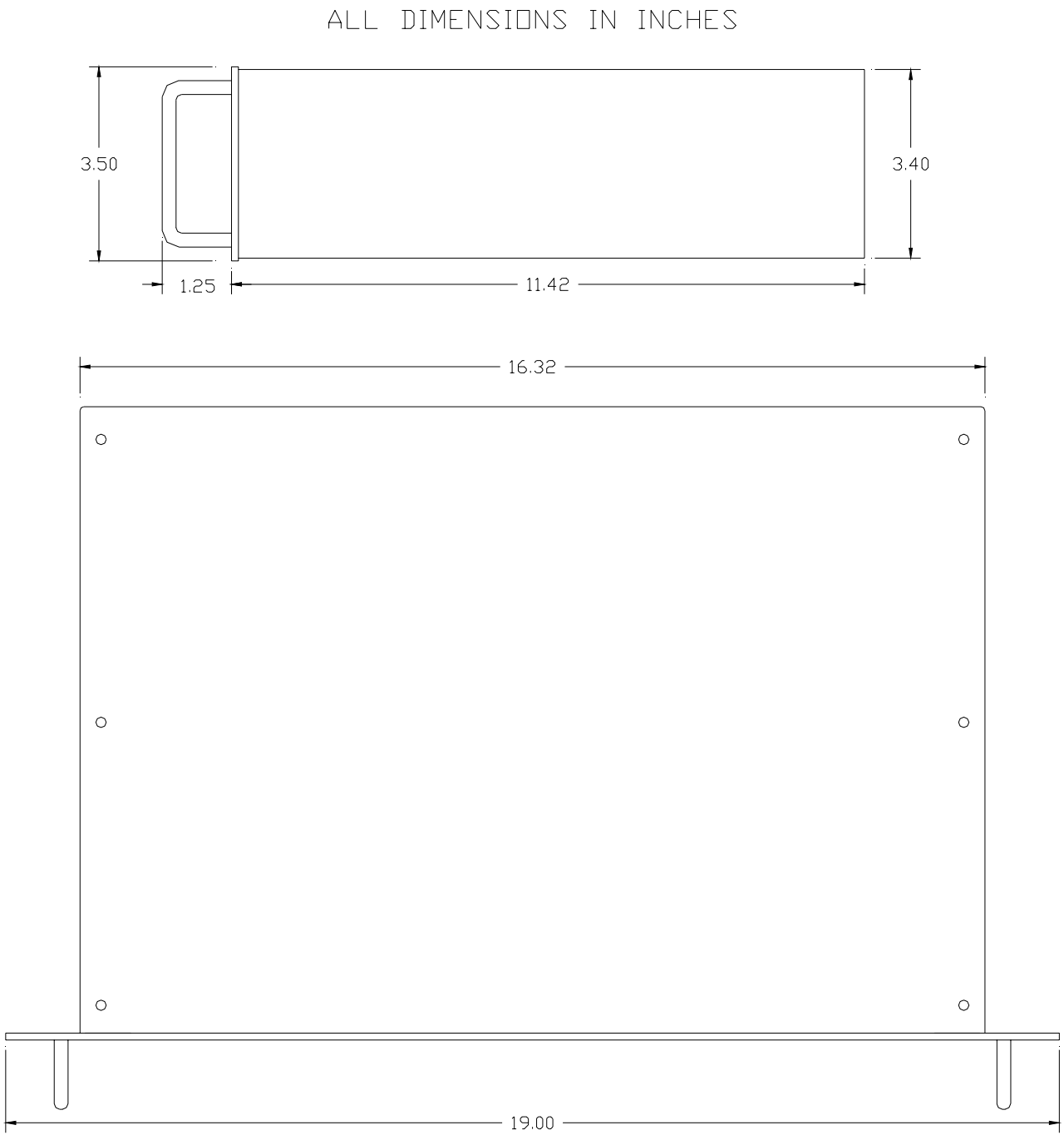

Figure 2-1 Outline Dimensions

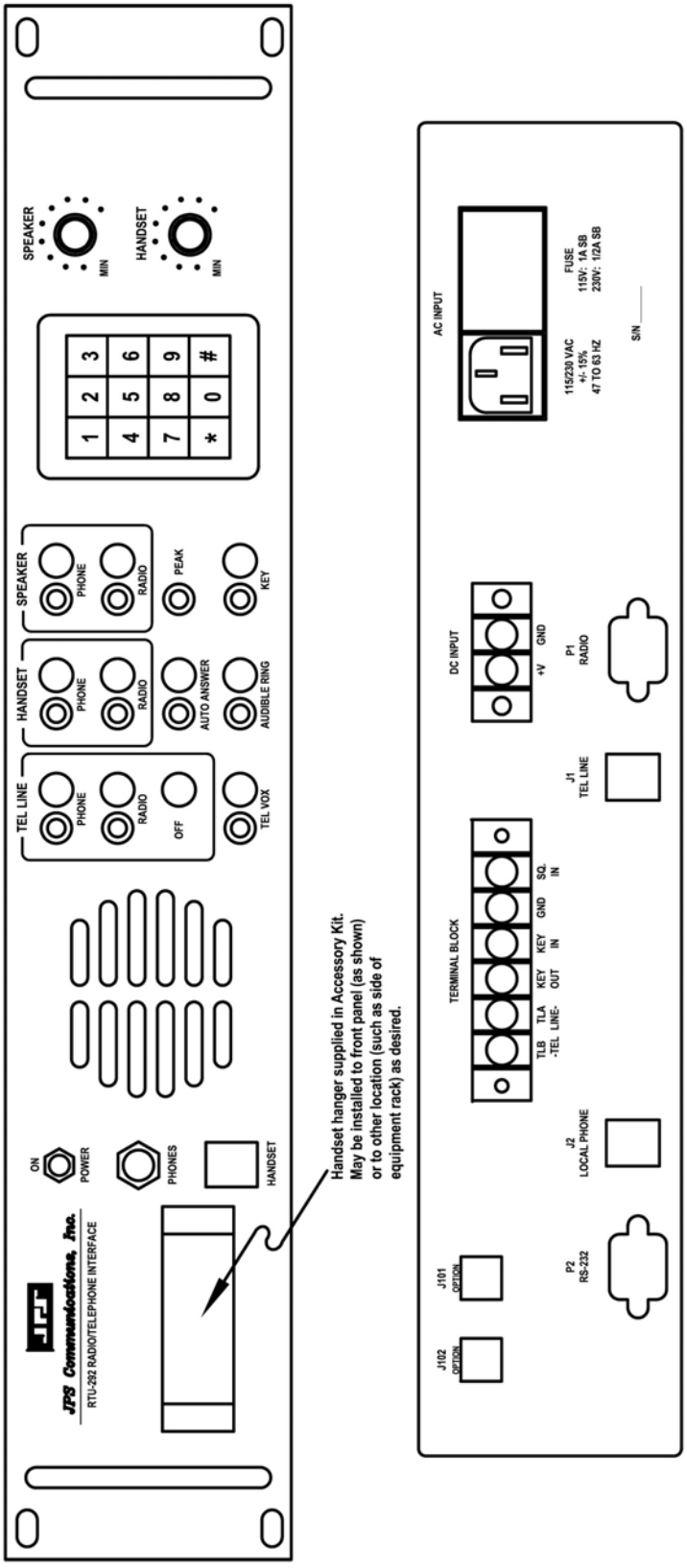

Figure 2-2 Control and Connector Locations

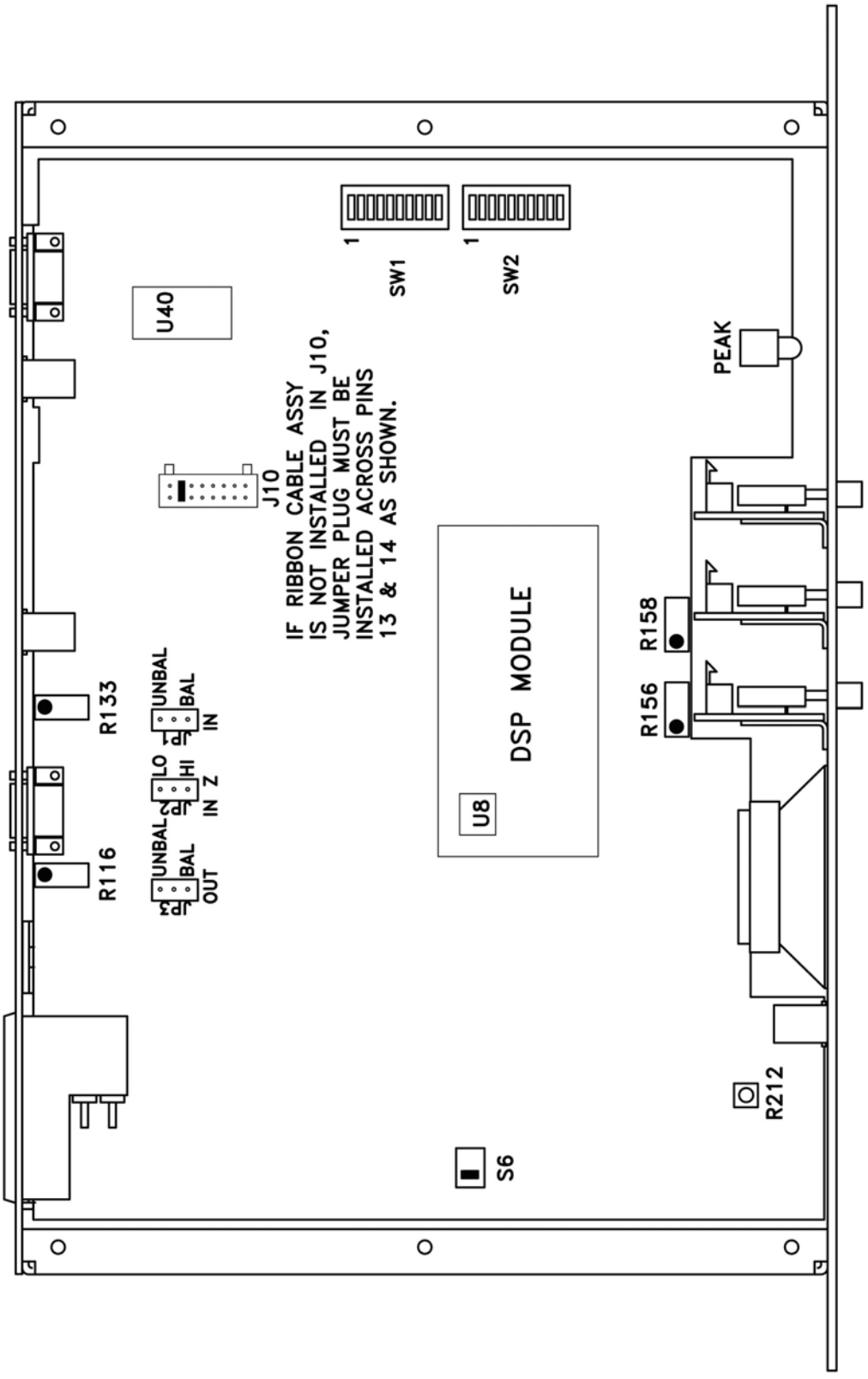

Figure 2-3 Location Of Internal Option Settings

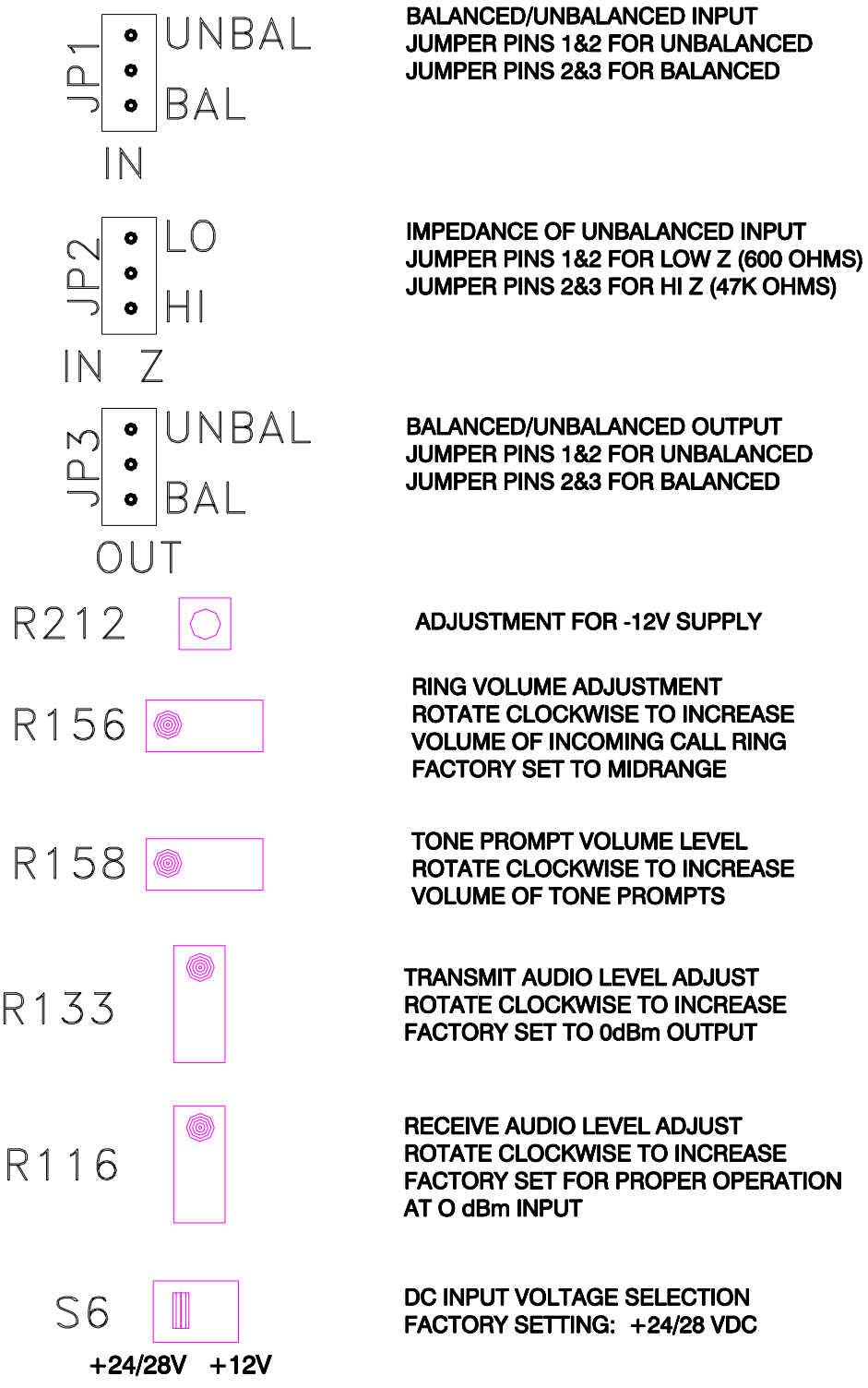

Figure 2-4 Internal Option Setting Details

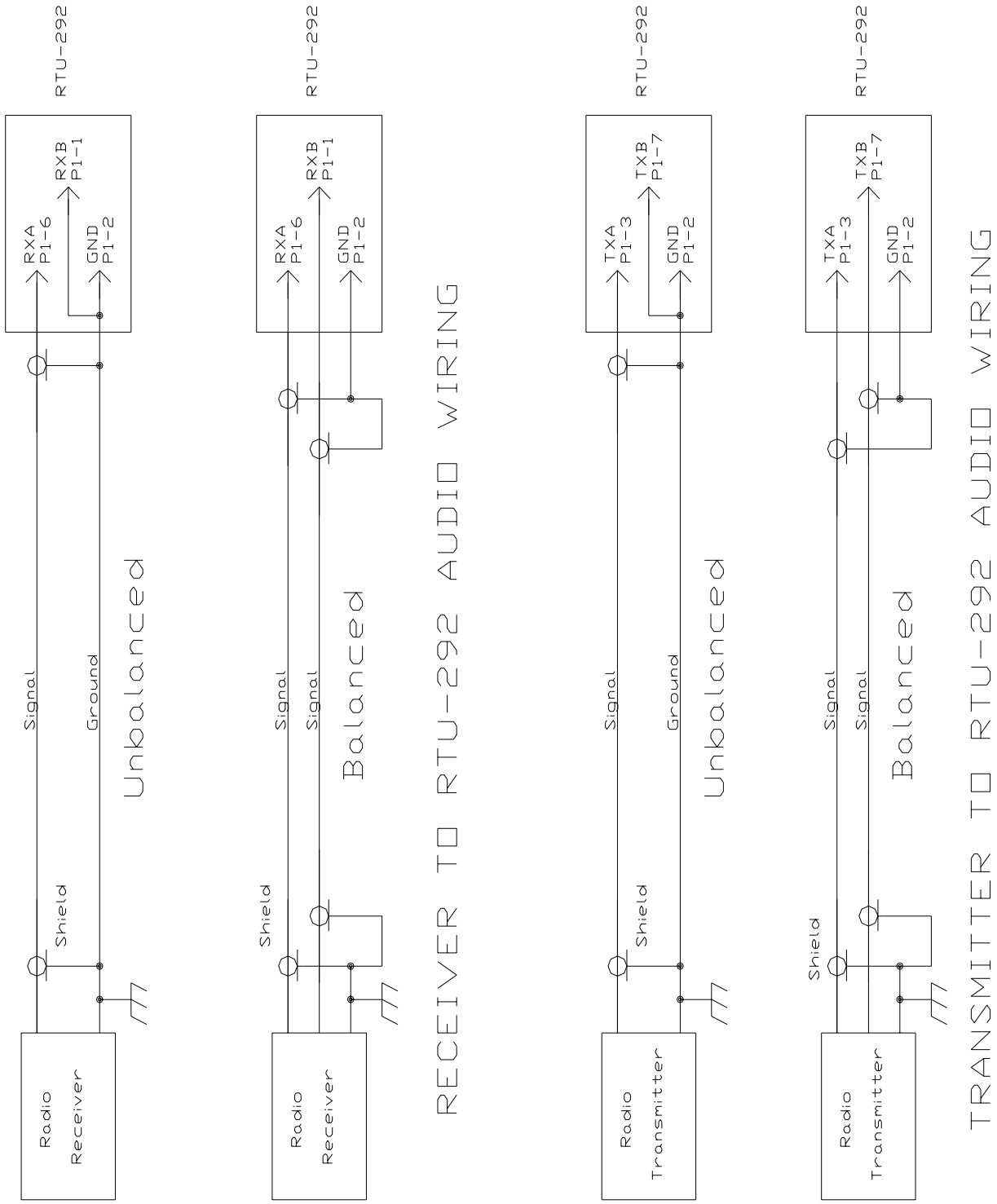

Figure 2-5 Audio Interface Wiring Diagram

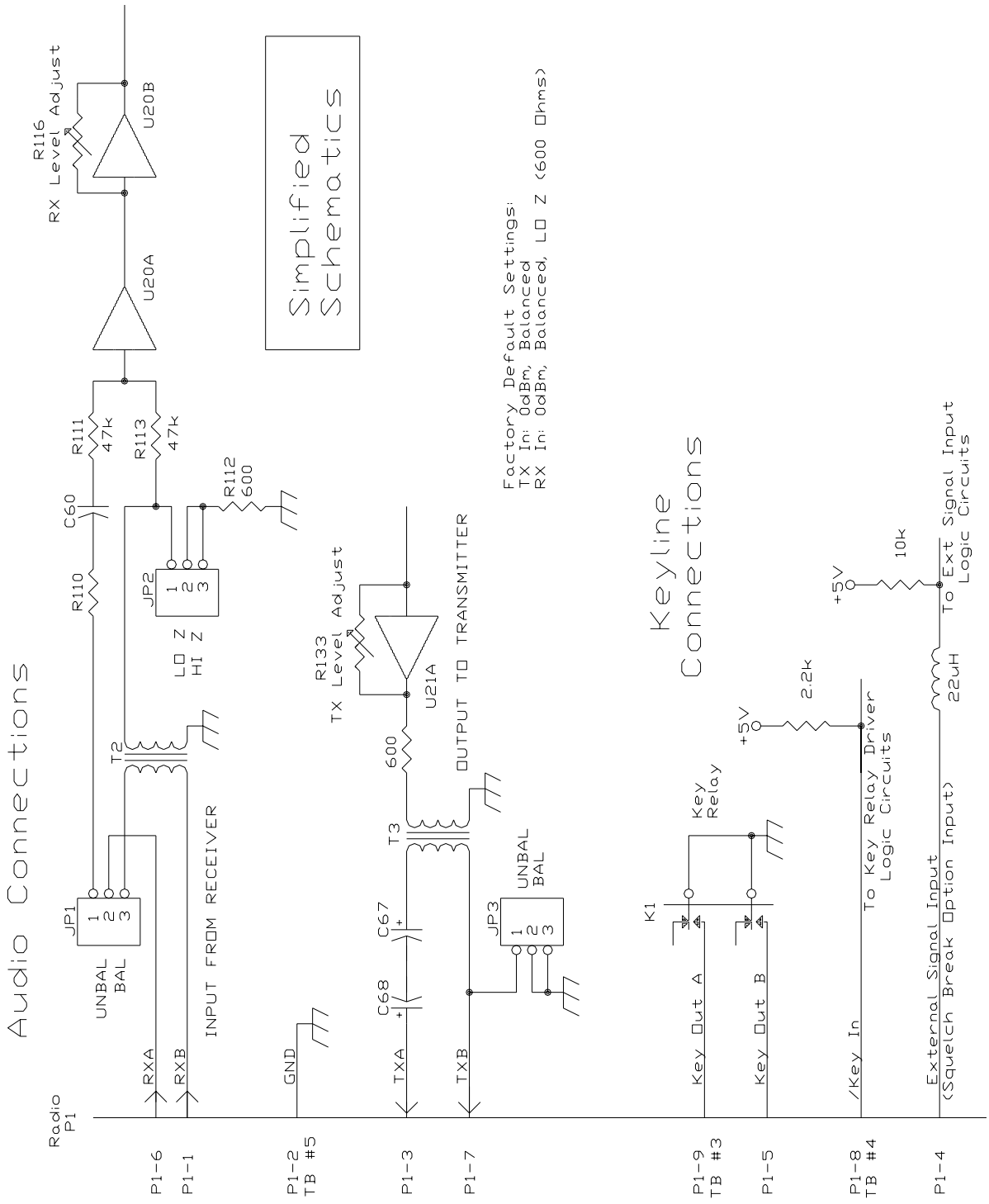

Figure 2-6 Interface Details

2.11 INSTALLATION CHECKLIST

Table 2-20 **Installation Checklist**	
Provide suitable **Mounting and Cooling.**	See Section 2.5.
Check **AC Line** voltage selection.	See Section 2.7.
DC Operation needed?	See Section 2.7.
Make **Interconnections.**	See Section 2.9 for External Interconnect Information.
Serial Remote Control needed?	Set Serial Remote Baud Rate with SW1-1 and 2. See RS-232 protocol in Section 5.
Set **TX/RX Audio Levels** if necessary.	See Table 2-1 and Section 2.10.
Set **Telephone Line Levels** if necessary.	See Table 2-1 and Section 2.8.
Are other **Factory Default Settings** correct for this system?	See Table 2-1 and Table 3-2. Make necessary changes as explained in sections 2.8, 2.10, and 3.7

2.12 OPTIONS INSTALLATION AND CONFIGURATION

See section 7 for installation instructions for all field-installable options. Section 7 also explains how to set-up any options that have configuration switches, jumpers, potentiometers, etc. For any options not covered in section 7, refer to custom notes supplied with the RTU-292 or the option, or contact JPS for information.

End of Section 2

3 Operation

3.1 GENERAL

This section contains information and instructions required for proper operation of the RTU-292.

3.2 FRONT PANEL CONTROLS, INDICATORS AND CONNECTORS

3.2.1 MAIN POWER SWITCH

The Main Power switch controls the external DC power to the unit. The switch is a locking toggle type to prevent inadvertent operation.

3.2.2 HEADPHONE JACK

This front panel jack accepts a standard 1/4 inch diameter monaural phone plug. The output will drive low, medium, or high impedance headphones. The phones audio level is adjustable via the PHONES VOLUME control on the right side of the panel.

3.2.3 HANDSET JACK

This front panel jack is a standard 6-pin RJ12C jack that connects the handset to the unit.

3.2.4 HANDSET

The handset allows sending and monitoring audio to and from either the telephone line, the radio, or both, depending on the HANDSET/PHONE and HANDSET/RADIO pushbutton selections. The handset also has a PTT (Push-To-Talk) switch to key an associated radio. The handset PTT switch is active only when any of the following functions are selected (associated LEDs on): TEL LINE/RADIO, HANDSET/RADIO, or SPEAKER/RADIO. The PTT switch need not be depressed when communicating with a second party via a PSTN line. The handset earpiece audio level is controlled by the HANDSET volume control. A convenient hanger for the handset may be attached to the left side of the front panel (mounting screws are installed in the front panel, remove the nuts from these screws, throw the nuts away, and use the screws to attach the hanger). This hanger, supplied in the RTU-292's accessory kit, may also be installed elsewhere on the equipment rack.

3.2.5 SPEAKER

The speaker allows monitoring of telephone line and/or radio audio, depending on the selections of the SPEAKER/PHONE and SPEAKER/RADIO monitor modes. In addition, the speaker serves as the telephone ringer for incoming calls. The speaker volume (except for the ring signal) is controlled by the SPEAKER volume control located on the right side of the front panel. The ring signal may be enabled or disabled by the AUDIBLE RING pushbutton. The ring volume is controlled by an internal potentiometer R156 (see section 2.8).

3.2.6 KEYPAD

The 12-key keypad is used for telephone dialing. It is active only when the TEL LINE/PHONE path is selected. Dialing may be either via DTMF mode or pulse mode as determined by internal dipswitch selection.

3.2.7 SPEAKER VOLUME CONTROL

This potentiometer controls the volume of audio (except telephone ringer volume) at the front panel speaker. Rotate clockwise to raise audio from minimum to full. Telephone ringer volume is controlled independently by an internal adjustment, R156 (see section 2.8).

3.2.8 PHONES VOLUME CONTROL

This potentiometer controls the signal level present at the front panel headphone jack and in the handset earpiece. Rotate clockwise to increase the audio level.

3.2.9 TEL LINE BUTTONS

These three buttons, PHONE, RADIO and OFF, determine whether the internal telephone, the radio, both, or neither (OFF) are connected to the telephone line.

Pushing the TEL LINE/PHONE button connects the RTU-292 internal telephone to the telephone line and allows dialing using the keypad. Pushing this button will also answer an incoming telephone call. The associated LED will be illuminated while the telephone line to internal phone path is selected.

Pushing the TEL LINE/RADIO button connects the telephone line to the radio through the DSP adaptive hybrid. The unit then starts its adaptation cycle by putting a burst of white noise onto the telephone line. When the adaptation cycle is underway, the TEL LINE/RADIO LED will flash. After successful completion of the adaptation cycle, this LED will be on continuously, indicating that the unit is ready for operation.

The TEL LINE/OFF pushbutton will hang up any active TEL LINE/RADIO or TEL LINE/PHONE connection.

3.2.10 HANDSET BUTTONS

These two buttons, PHONE and RADIO, allow the handset to be connected to the internal telephone, the radio, or both simultaneously. Each button has an associated LED that is illuminated when the path is active.

Pushing the HANDSET/PHONE button connects the handset to the telephone audio path ad activates the handset microphone. Note that this will not take the telephone off-hook; the TEL LINE/PHONE LED must also be on for the handset to be used to communicate over the telephone line.

Pushing the HANDSET/RADIO button selects the handset to the radio audio path. When this path is selected (HANDSET/RADIO LED is on) the handset PTT switch will key the radio transmitter.

If both paths are simultaneously selected, the audio heard in the earpiece will be the radio receive and telephone audio mixed together, and microphone input will be sent both to the telephone line and to the radio transmitter.

3.2.11 SPEAKER BUTTONS

These two buttons, SPEAKER/PHONE and SPEAKER/RADIO, determine whether the speaker monitors telephone receive audio, radio receive audio, or both. Note that if a radio-to-telephone call is underway and both buttons are pressed, the full conversation is being monitored. There is an LED alongside each button that is illuminated when the associated path is selected.

3.2.12 TEL VOX

This button enables keying of the radio transmitter by the RTU-292 VOX (Voice Operated Xmit) facility. When the VOX is selected (associated LED ON), the VOX is active, and the key relay is energized when the VOX circuitry detects a signal from the telephone line. The VOX PTT output has a "hang" time to keep it from dropping out during short pauses in speech. The hang time duration is the length of time that the PTT signal will remain active following the loss of detection of signal. (The hang time is internally adjustable; see section 2.8). If the TEL LINE/RADIO LED continues to flash for more than ten seconds after the TEL LINE/RADIO pushbutton has been pressed to make a connection, the unit has not adapted properly and VOX operation will not be possible.

3.2.13 AUTO ANS BUTTON

This pushbutton may be used to manually enable (LED ON), or disable (LED OFF), the Auto Answer feature. When enabled, the RTU-292 is in the Automated Operation Mode and the unit will automatically answer the phone after 2 rings. See section 3.7 for a description of the Automatic Operation capabilities of the RTU-292.

3.2.14 AUDIBLE RING BUTTON

This button determines if the ring from an incoming telephone call will be heard via the RTU-292's speaker. When the Audible Ring mode is enabled, the ring signal will be audible in the speaker. The ring volume is independent of the SPEAKER VOLUME setting, and is set internally by adjustment R156. Regardless of the position of the AUDIBLE RING button, the LED indicator associated with the TEL LINE/PHONE button flashes on an incoming ring, so that a visual indication of the ring signal (incoming call) is always provided.

3.2.15 KEY PUSHBUTTON

This pushbutton operates the key function of the RTU-292, sending a key command to the associated transmitter. This button is functional at all times. The red KEYED LED next to the KEY pushbutton is lit whenever a key command is sent to the transmitter from any source within the RTU-292 (handset keyswitch, or TEL VOX, for example), not just from the KEY pushbutton.

3.2.16 PEAK LED

This red LED flashes on audio peaks that are detected in the audio incoming from the receiver to indicate the proper adjustment of the internal RX LEVEL control (R116). The input level is correct when the PEAK LED flashes occasionally on incoming receiver speech peaks. If the LED flashes continuously, the input level is too high and should be reduced (see paragraph 2.10). Note that this LED does not respond to telephone audio.

3.3 REAR PANEL CONNECTORS

Accessible at the RTU-292 rear panel are the radio connector, telephone line and local phone connector, the signal terminal block, the DC power terminal block, an RS-232 connector, and the AC power connector/voltage selector/fuse holder assembly. See section 2.9 for full pin-out information.

3.3.1 P1 RADIO CONNECTOR

This male DB9 connector is the interface between a radio system and the RTU-292. It contains transmit audio, receive audio, and keylines.

3.3.2 J1 TEL LINE

The RJ11C jack provides the telephone line connection to the RTU-292. The telephone line connections are also available at the terminal block.

3.3.3 TERMINAL BLOCK

The terminal block is provided mainly as a convenience for the connection of the telephone line to the unit if an RJ-11C plug is not available. This block also contains the key relay contacts to the transmitter, remote key input signal, ground, and a spare External Signal Input.

3.3.4 J2 LOCAL PHONE CONNECTOR

This RJ-11C jack is used to connect a local phone to the unit. The Local Phone Option must be installed for this port to be active.

3.3.5 P2 RS-232 CONNECTOR

This female DB-9 connector provides an interface between the RTU-292 and a radio or a controlling terminal via standard RS-232 signal lines.

3.3.6 DC INPUT TERMINAL BLOCK

This two-position terminal strip has a pair of screw terminals, one for a ground wire and another for the DC input of either +12 or +24/+28VDC (nominal). Internal slide switch S6 is used to select between +12 and +24/+28 volt input. Refer to section 2.7.

3.3.7 P1 AC POWER CONNECTOR

This is a combination AC power connector, fuse holder and line voltage selector. It incorporates a line filter to reduce the possibility of RF pickup by the power line from close-proximity transmitters. Section 2.7 has complete instructions for the line voltage selection and fuse replacement.

3.4 OPERATION

3.4.1 OPERATION OVERVIEW

The RTU-292 is a flexible piece of equipment that contains a telephone and a radio/telephone interface circuit with a unique adaptive hybrid. These circuits are arranged so that they can be used together or independently in several different ways. The unit may be used to manually create the telephone to radio connection, or an unmanned connection can be made in the automated mode. Here are some examples of RTU-292 operating modes:

1. The telephone may be used to place and receive calls independently of the radio interface.
2. The speaker may be used to monitor radio traffic while the handset is used with the internal telephone to place a telephone call.
3. The handset may be used to transmit/receive from the radio.
4. The radio may be connected to the phone line through the adaptive hybrid.
5. A phone call may be patched through to a radio link, or a radio link patched into a phone line. This can be accomplished unattended using a pair of RTU-292s in the Automated Mode.

The following paragraphs describe the RTU-292 operating modes in detail.

3.4.2 USE OF THE RTU-292 SPEAKER TO MONITOR AUDIO

1. To monitor radio receive audio, push the SPEAKER/RADIO button. The associated LED will light.
2. To monitor telephone audio, push the SPEAKER/PHONE button. The associated LED will light. Either the TEL LINE/PHONE or the TEL LINE/RADIO LED must be ON, indicating that the telephone is off-hook, or there will be no audio present.
3. Note that radio receive audio and telephone audio may be simultaneously monitored.

3.4.3 PLACING A TELEPHONE CALL

1. Ensure that telephone audio will be available at the handset (HANDSET/PHONE LED is ON).
2. Connect the RTU-292 to the outside phone line by pressing the TEL LINE/PHONE button; listen for the dial tone.
3. When dial tone is heard, dial the desired number using the keypad. The handset will function like an ordinary telephone handset.
4. If desired, the phone conversation may also be monitored via the front panel speaker by depressing the SPEAKER/PHONE switch (SPEAKER/PHONE LED ON). Prevent feedback by controlling speaker volume and keeping the handset a sufficient distance from the speaker.
5. To hang up, press the TEL LINE/PHONE button, or the TEL-LINE OFF button, so that the TEL LINE/PHONE LED goes out.

3.4.4 RECEIVING A TELEPHONE CALL

NOTE

The handset-to-telephone path may be left in the enabled condition (HANDSET/PHONE LED ON) even when the unit is not connected to the telephone line. Only one button (TEL LINE/PHONE) must then be pushed to answer the telephone. The following scenario assumes that the HANDSET/PHONE LED is already ON.

1. When the ring is heard (or the flashing TEL LINE/PHONE LED is observed) indicating an incoming call, push the TEL LINE/PHONE button and speak into the handset. It isn't necessary to press the handset PTT switch to use the telephone.
2. To hang up, press the TEL LINE/PHONE button again. The adjacent LED will turn off.

3.4.5 PUTTING A TELEPHONE CALL ON HOLD

Once a telephone call has been received or initiated and the TEL LINE/PHONE LED is illuminated, pressing the HANDSET/PHONE button or the SPEAKER/PHONE button will put the call on "hold". (The call will not be cut off as long as the TEL LINE/PHONE button is not pressed.)

For example, if the RTU-292 operator has made a telephone connection and wishes to contact a radio party to continue setting up the patch, he may place the telephone call on "hold" and speak with the radio party using the handset as described in 3.4.6.

3.4.6 USING THE HANDSET WITH THE RADIO

Pressing the HANDSET/RADIO button will connect the handset to the radio's audio lines (associated LED will be on). The receive audio will be heard in the earpiece, and when the radio is keyed (via the handset or front panel key switches) the handset mic audio will be routed to the transmitter. The SPEAKER/RADIO pushbutton may also be used to monitor radio receive audio via the RTU-292's front panel speaker.

3.4.7 CONNECTING THE RADIO TO THE TELEPHONE LINE

To patch the radio to the telephone line, push the TEL LINE/RADIO button to ON. This will cause the adaptive hybrid to operate in the following manner:

3.4.7.1 Initial Adaptation

The two-wire to four-wire hybrid in the RTU-292 adapts to the phone line each time the TEL LINE/RADIO button is engaged. To adapt, it measures the characteristics of the line by placing a white noise source (built into the unit), on the line for a short time. While the noise burst is connected, the amount of signal "reflected" from the phone line is measured and adaptation begins. The adaptation algorithm adjusts the adaptive hybrid to minimize the reflected signal, throughout the audio frequency spectrum, from the phone line. During the adaptation process, the TEL LINE/RADIO LED will flash. When adaptation is complete, the

noise source is switched off, the LED is lit continuously, and the unit is ready for operation. This adaptation procedure normally takes less than one second.

For adaptation to be successful, the far end of the phone line must be quiet (there must be no signal coming into the RTU-292 from the phone line during adaptation). If there is incoming audio, the unit may not be able to adapt, but will keep trying for up to ten seconds. For example, the telephone user at the far end of the phone line should not talk during the adaptation cycle. If the TEL LINE/RADIO LED does not stop flashing within the normal second or two after the TEL LINE/RADIO button is pushed, wait a short time longer. If the LED still continues to flash, chances are that there is excessive noise on the phone line, and it is best to hang up and redial.

Because the adaptation algorithm is very robust, connection to an unquiet phone line is about the only case where the RTU-292 will fail to adapt, as the hybrid has the ability to adapt to line conditions from a short-circuit to an open-circuit, as well as the impedance presented by the extremely complex distributed network of a telephone line.

3.4.7.2 CONTINUOUS ADAPTATION

Once the initial adaptation is complete and the unit begins operating, hybrid adaptation proceeds continuously using receiver audio sent down the telephone line (the noise burst is not needed again). This feature enables the RTU-292 to automatically adapt its hybrid balance to changing line conditions.

3.4.8 MANUAL PHONE PATCH PROCEDURE

A telephone patch establishes a communications link between a distant radio, a local radio (interfaced directly to the RTU-292 via the P1 Radio connector) and a distant telephone that is connected to the unit via the telephone line. This distant telephone will be patched through the local radio set to the distant radio set allowing communication directly between the distant radio set and the distant telephone.

Begin with the RTU-292 installed and its power on:

3.4.8.1

The operator first establishes a link between the local radio set and the distant radio set using the RTU-292's handset with the radio, as described in paragraph 3.4.6. Alternatively, the operator may have received a radio call from a distant radio party wishing to make a phone patch.

Using the RTU-292's internal telephone set, the operator now places a call to the distant telephone.

Or

3.4.8.2

The operator begins the procedure by using the RTU-292's internal telephone set to place a call to the distant telephone party. Alternatively, The operator may have received a call from a distant telephone party wishing to make a phone patch. He then places the telephone party on hold while the distant radio party is contacted.

The operator then establishes a link between the local radio set and the distant radio set using the RTU-292's handset with the radio, as described in paragraph 3.4.6.

3.4.8.3

Once the telephone and radio party have both been contacted, the operator should advise the telephone party that a phone patch is being set up. He may want to advise that a short noise burst (not extremely loud) will be heard in the telephone receiver, and that the conversation can proceed following the burst. The operator then pushes the TEL LINE/RADIO button to begin adaptation, indicated by a flashing TEL LINE/RADIO LED.

3.4.8.4

After the RTU-292 automatically adapts itself to the phone line, and the TEL LINE/RADIO LED will stop flashing and stay continuously illuminated. This indicates that a complete link has been established between the distant radio set and the distant telephone, via the RTU-292 and the local radio set.

3.4.8.5

Progress of the call may be monitored via the speaker on the RTU-292 front using the SPEAKER/PHONE and SPEAKER/RADIO buttons.

3.4.8.6

The call may also be monitored with the handset. The operator may speak and listen to either the telephone party alone, the radio party alone, or both together, using the HANDSET pushbuttons.

3.4.8.7

When the conversation is complete, the operator pushes the TEL LINE OFF button to disconnect from the phone line. The TEL LINE/RADIO and TEL LINE/PHONE LEDs will both turn off, indicating that the phone is back on-hook (disconnected).

3.4.9 TRANSMITTER KEYING, HALF DUPLEX SYSTEM

For a normal half-duplex radio link, it is usual for the VOX in the RTU-292 to key the transmitter. The VOX responds to signals from the telephone line and operates the keying circuits when voice is present. Once the VOX has tripped, it remains active for the selected "hang time" following the loss of audio to prevent dropout on pauses between syllables. The unit also incorporates a short delay of the transmitted audio, which allows the VOX to key the transmitter a short time before the audio arrives, so that the RF output can be at full power to avoid missing part of the first syllable.

The VOX in the RTU-292 is generated within the DSP and is extremely sensitive and reliable. However, there are occasions when the audio level from the telephone line is too low to operate the VOX reliably, or for some other reason it is desired to key the transmitter manually. To do this, operate the front panel KEY pushbutton or the handset PTT button to key the transmitter. The VOX switch can be left engaged, if desired, so that the operator can override the VOX at any time, or the VOX may be disengaged, so all keying occurs manually.

3.4.10 TRANSMITTER KEYING, FULL DUPLEX SYSTEM

In a full duplex system, the transmitter can be held continuously keyed during a conversation, because the system can receive and transmit at the same time. Thus, VOX is not required. In this case, the transmitter may be keyed from the RTU-292 by pulling either of its external KEY inputs low. The Full/Half Duplex dipswitch setting has no effect on transmitter keying.

3.5 REMOTE KEY

The RTU-292 contains a remote /Key signal that can be activated at any time. The unit will key the transmitter any time this input is pulled low while the power is on.

3.6 SELF TEST

The RTU-292 self-test routine operates each time the unit is powered up. This routine tests the non-volatile RAM for out-of-range parameters and various functions of the DSP module. The unit also performs a "Walking LED" test, turning each of the front panel LEDs on in succession, providing an indication of correct I/O operation. A successful self-test will be indicated by the "Positive Acknowledge" tone prompt and, if the Voice Prompt Option is enabled, the "*RTU-292 Automatic Phone Patch*" greeting prompt. Failure of the self test (or failure of the DSP module at any time) is indicated by a long "Negative Acknowledge) tone and a constantly blinking PEAK LED. The radio connect functions of the unit will not operate, although the telephone may continue to operate.

3.7 AUTOMATED OPERATION

The RTU-292 can patch the telephone line to a radio system completely unattended when in the Automated Operation Mode. To enter this mode, simply press the AUTO ANSWER pushbutton. The unit will signal its present status and request remote operator responses through the use of Tone Prompts and (if equipped) with actual voice messages called voice prompts.

3.7.1 TONE PROMPTS

The RTU-292's tone prompt sequences and their meanings are:

3.7.1.1 Positive Acknowledge (ACK)

When the RTU-292 wants to signal an acknowledge it will play 1 short high-pitched tone followed by 1 short low-pitched tone. The RTU-292 usually plays an ACK in response to a user-initiated command. ACK means that the command was received and was legitimate

3.7.1.2 Negative Acknowledge (ERROR)

When the RTU-292 wants to signal a negative acknowledge or error it will play 1 long low-pitched tone. An ERROR is usually played as a response to incorrect user entry, or following the receipt of an illegitimate command that could not be executed.

3.7.1.3 Waiting For Input (QUERY)

When the RTU-292 needs user input it will play 1 short low-pitched tone followed by 1 short high pitched tone. A QUERY is played whenever the user needs to enter some data such as a password or telephone number.

3.7.1.4 Radio Is Keyed (KEYED)

When the RTU-292 wants to signal that the user has keyed the radio it will play 1 short high-pitched tone. The RTU-292 will play KEYED whenever the user has manually keyed the radio by entering the correct telephone command.

3.7.1.5 Radio Is Unkeyed (UNKEYED)

When the RTU-292 wants to signal that the user has unkeyed the radio it will play 1 short low-pitched tone. The RTU-292 will play UNKEYED whenever the user has manually unkeyed the radio by entering the UNKEY telephone command.

3.7.1.6 Disconnecting (DISCONNECT)

When the RTU-292 wants to signal that it is dropping the radio communications link (and hanging up the phone) it will play 3 short high-pitched tones. The RTU-292 may disconnect for a number of reasons:

1. Any time the user enters a * (star) followed by a # (pound sign).
2. Whenever Busy Tones or Reorder tones are heard on the phone line. The DSP algorithms are always searching for call progress activity on the phone line.
3. The unit will also disconnect if there is a lack of any activity on the phone line for a time longer that that set by the Inactivity Timer (see Table 3-1). If the unit signals that it is dropping the link due to a lack of activity, either party may prevent the disconnection by speaking within five seconds.
4. Whenever "Line Reversal" (Reverse Battery Signaling) is detected on the phone line.

3.7.2 VOICE PROMPTS

If the RTU-292 is equipped with the Voice Prompt Option it will prompt the user for input and signal its current status to the user status by playing pre-recorded messages, called voice prompts. Tone prompts are played before each voice prompt. For example, if the RTU-292 wanted the user to enter the password it would play the QUERY tone sequence followed by the voice prompt "*Enter Password*". The number of different tone prompts is limited because the average user cannot be expected to remember more than a few. However, since voice prompts are largely self-explanatory the RTU-292 has more than 30 different voice prompts. The remainder of this section includes a description of the voice prompts that the unit provides at appropriate times during unit operation. These prompts are only heard if the Voice Prompt Option is installed.

3.7.3 CALLING THE RTU-292 VIA THE OUTSIDE LINE

If the RTU-292 is set for Automatic Answer (AUTO ANSWER LED lit) it will answer an outside call after 2 rings. Once the unit answers the phone, the caller controls the unit by sending commands via the keypad of a DTMF telephone. Rotary-style telephones cannot be used to control the RTU-292.

The following paragraphs describe the sequence of operations used to automatically place a call through the RTU-292 to a radio via the outside phone line. This description assumes that the RTU-292 has a Voice Prompt Option installed. Units without a Voice Prompt Option will function identically except for a lack of voice prompt messages. The tone prompts listed in 3.7.1 are provided by the RTU-292 whether or not the Voice Prompt Option is installed.

3.7.3.1 The Caller Dials The RTU-292

When a call is made over the telephone line by a distant telephone to the RTU-292, the unit answers the phone and plays the greeting voice prompt: *"RTU-292 Automatic Phone Patch"*. If password protection is enabled the unit plays the QUERY tones followed by the "*Enter Password*" voice prompt. If password protection is not enabled the unit will move directly to the adaptation process (3.7.3.3).

3.7.3.2 The Caller Enters The Password (if enabled)

The password is a sequence of numbers (0-9). The password may range from 1 digit up to 10 digits. When the RTU-292 is shipped from the factory it is given the default password "1 2 3 4". The password may contain only numbers (no * or # characters). If the user enters an incorrect password the RTU-292 will give him two additional tries. If the unit has the Voice Prompt Option installed, voice prompts will guide the user in trying again to enter the correct prompt. Otherwise, the "Query" prompt will be given. If the correct password is still not entered after three tries, the unit will then play the DISCONNECT tones and immediately hang up. When the unit receives the correct password, it moves on to the adaptation process. See 3.7.3.4 for instructions related to changing the existing password.

3.7.3.3 The RTU-292 Adapts To The Phone Line

The RTU-292 hardware has an Adaptive Hybrid that is controlled by a Digital Signal Processor (DSP). The hybrid matches the RTU-292 to the telephone line and also allows the radio to be keyed automatically by detecting the presence of the caller's voice on the telephone input. This "Voice Operated Transmit" method of keying is called VOX. Note that the VOX will be activated for any type of signal on the input, whether it is speech or any other energy above the VOX sensitivity level.

Before the DSP can accurately detect the caller's voice the RTU-292 must first "adapt" to current phone line conditions. During the adaptation process the DSP will momentarily emit white noise on the phone line. This noise burst sounds like a loud hiss. It is important for successful adaptation that the caller does not talk or enter any DTMF commands during the adaptation process. It helps to keep the phone line as quiet as possible. The adaptation process will normally take less than two seconds to complete, but under noisy line conditions the process may take as long as 10 seconds. During the adaptation process, the DSP measures the white noise that is reflected back from the phone line and matches the RTU-292 to minimize the reflected signal. This process is completely automatic and requires no user adjustments.

After the DSP has adapted, the RTU-292 will play the ACK (acknowledge) tones and give the "*Ready*" voice prompt (if the Voice Prompt Option is installed). If the DSP cannot adapt, the unit will play the ERROR tone and give a "*VOX Unavailable*" voice prompt. If VOX is unavailable the caller must give a "KEY" command before speaking, and then give an "UNKEY" command turn off the transmitter and listen to the reply (see 3.7.3.4).

3.7.3.4 The RTU-292 Enters the COMMAND Mode

After the RTU-292 completes the adaptation sequence, it enters the Command Mode and waits for the caller to respond with commands. In Command Mode the user may enter DTMF commands by pressing a number on the telephone's keypad. The unit stays in Command Mode until the caller gives the * # sequence to hang up. If the caller gives an incorrect command the unit plays the ERROR tone and gives the "*Invalid Entry*" voice prompt.

When the RTU-292 is used in the command mode, it is connected to a radio system that is ready to respond to the basic RTU-292 commands. At a minimum, the radio must be turned on and set to the appropriate frequencies, and the radio audio and PTT input lines must be connected to the RTU-292. One of the dipswitches allows the RTU-292 to be put into the Radio Control Mode via a DTMF command. This mode enables the RTU-292 to control a companion Motorola URC-200 radio via its RS-232 serial port. See Tables 2-9, 3-1 and 3-3.

NOTE

It is important to note that only the distant phone connected to the telephone line is routed through the DSP and therefore it is the only phone that can use the RTU-292's VOX function. The local phone and the unit's handset and keypad do not have VOX capability. Operators using the local phone or the handset to communicate via the radio must always disable the VOX function and manually key and unkey the transmitter.

3.7.4 PLACING A CALL IN THE COMMAND MODE:

When a phone call is initiated by the RTU-292 to a distant phone on the outside line, and the called party picks up the phone, the unit's DSP will immediately execute the adaptation process. When it is successful, the RTU-292 responds with the "*READY*" voice prompt. If the DSP could not adapt, the RTU-292 gives the "*VOX UNAVAILABLE*" prompt, informing the recipient of the call that he must manually key and unkey the transmitter. All other operation procedures are the same as when a call is initiated by the distant telephone to the RTU-292.

3.7.5 TERMINATING A CALL:

There are several different ways to terminate a call.

1. If the PSTN that the RTU-292 is connected to has "Reverse Battery Signaling" (sometimes called "line reversal"), the call will be terminated whenever the telephone caller hangs up the phone. Reverse Battery Signaling is used by most domestic US phone systems, but is not widely used outside of the US. Reverse Battery Signaling momentarily inverts the tip and ring lines to signal that a caller has gone back on-hook (hung-up).
2. The sequence * # will cause the system to disconnect. This sequence may be given at ANY time, even when the system is prompting for input. If Reverse Battery Signaling is not present, the * # termination sequence is always required at the distant phone, as the RTU-292 will not be aware that the call has been terminated unless the unit receives Busy or Reorder call progress tones. Otherwise the link will not be disconnected until the inactivity timer expires (see table 3-1 for information about setting the inactivity timer duration). If

the unit signals that it is dropping the link due to a lack of activity, either party may prevent the disconnection by speaking within five seconds.

3. Pressing the OFF button on the front panel of the RTU-292 will also cause the system to disconnect.
4. When the local phone is used, its operator may use the * # sequence or may simply hang up the phone.

3.7.6 DTMF CONTROL COMMANDS

Tables 3-1, 3-2, and 3-3 explain and list the RTU-292's various DTMF command modes. DTMF commands may be entered via a connected telephone, a telephone set when the Local Phone Option is installed, or via the front panel keypad*. Additionally, the DTMF keypad on a radio may be used to make connections (see DTMF Access Option, 3.7.11).

* Some restrictions apply when sending commands via the front panel keypad:

3.7.6.1 OPERATING THE RTU-292 FROM THE FRONT PANEL KEYPAD

The RTU-292 can be operated from its front panel to allow the unit to be programmed, and if so equipped, control a Motorola URC-200 radio. When using the front panel, the operator uses the handset and keypad.

To begin front panel operation the user must enter three "*" keypresses. The RTU-292 will respond with an Acknowledge tone prompt and the voice prompt "*READY*". At this point all front panel keypad entries are treated just as though the user were sending commands via the telephone or local phone.

Front panel control operation will continue until one of the following conditions occurs:

- The user enters a "*#" sequence.
- There is no PTT activity or keypad activity for the duration of the activity timer.

While the operator is using the keypad to control the RTU-292, the unit will not be available for:

- PSTN Auto Answering.
- Radio Squelch Break Access (S/W option).
- Radio DTMF Control (S/W option).
- Local Phone Control (H/W option).

Table 3-1 **Standard DTMF Operational Commands**

These commands may be entered by the RTU-292 front panel keypad, or by the keypad of a connected telephone or by a telephone set wired to the Local Phone Option. See 3.7.6 for special instructions regarding the use of the front panel keypad to send DTMF Commands.

DTMF Command	Function
* #	Terminate the call.
* 0	Manual Keying Toggle. Press once to key; the next press will unkey, etc. To prevent simultaneous use of VOX and Manual Keying, if VOX was enabled when * 0 is first entered, it will be shut off.
* 1	VOX Toggle. If VOX is on, * 1 will turn it off. If VOX is off, * 1 will turn it on.
* 2	VMR Toggle. If VMR is on, * 2 will turn it off. If VMR is off, * 2 will turn it on. VMM-100 Option must be installed
* 3	Noise Reduction Toggle. If Noise Reduction is on, * 3 will turn it off. If it's off, * 3 will turn it on. VMM-100 Option must be installed.
* 4	Security Mode Toggle. If Security Mode is on, * 4 will turn it off. If it's off, * 4 will turn it on. Security Device Option must be installed (not currently available).
* 5	Page the Operator (make a call to the RTU-292 operator at the front panel keypad / handset).
* 6	Page the Local Phone Operator (this command can obviously made only by a connected telephone and not by the Local Phone).
* 7	Reserved for future use.
* 8	Radio Control Mode. (Requires optional radio control S/W.) Use this command to enter the Radio Control Mode (dipswitch SW1-3 must also be ON to enable this mode). This mode enables DTMF control of a companion Motorola URC-200 radio. See Section 7. If the RTU-292 is in the Radio Control Mode, * # will return it to standard RS-232 control mode. See Table 7-6.
* 99	Enter the programming mode. If passwords are enabled, the user will be prompted for the system password and not allowed to enter the programming mode unless the password is correctly entered. See Table 3-2.

Table 3-2 **Programming Mode DTMF Commands**

These commands may be entered by the RTU-292 front panel keypad*, or by the keypad of a connected telephone or by a telephone set wired to the Local Phone Option. The unit must be put into the programming mode by entering *99 before these commands can be executed. *See 3.7.6 for special instructions regarding the use of the RTU-292 keypad.

DTMF Command	Function	
* 0 x	Call Logging Enable/Disable. * 0 0 Disables Call Logging (factory default is disabled). * 0 1 Enables Call Logging. See 3. 7.13.	
* 1 x x x #	Change the password to "xxx". Terminate entry with #. Password may be up to 10 digits long. Factory default is 1 2 3 4.	
* 2 x	Program the inactivity disconnect timer based on value of "x". See 3.7.8 for more information.	
	* 2 0	Disabled (not recommended see 3.7.8)
	* 2 1	2 Minutes
	* 2 2	5 Minutes (factory default)
	* 2 3	10 Minutes
	* 2 4	20 Minutes
	* 2 5	30 Minutes
	* 2 6	45 Minutes
	* 2 7	60 Minutes
	* 2 8	90 Minutes
	* 2 9	120 Minutes
* 3x	Program the Calling Timer based on the value of “x”. The RTU-292 will attempt to place a call to a telephone until this timer expires. See 3.7.8 for more complete information.	
	* 3 0	30 Seconds (factory default)
	* 3 1	1 Minute
* 4xx	Program Speed Dial Entry “xx”. See 3.7.10.	
* 5	Review Speed Dial Entry “xx”.	
* 6 x	Select 2 wire or 4 wire operation based on the value of “x”. See 3.7.15	
	* 6 0	2 wire operation (factory default)
	* 6 1	4 wire operation
	* 6 #	Query to learn current setting
* 7 & * 8	Reserved for future use.	
* 9	Reserved for JPS Manufacturing	
* #	Leave Programming Mode	

3.7.7 RTU-292 PASSWORD PROTECTION

The password protection feature is enabled by a dipswitch setting (SW1-5, see Table 2-1). When passwords are enabled, access to the system is denied unless a user enters the correct password. The same password applies both to access via telephone and via a radio (if the DTMF Radio Access feature is used). Users are given three tries to correctly enter the system password before the RTU-292 terminates the call attempt and returns to its waiting state.

The system assists the user in entering the password by the use of Voice and Tone Prompts (if the Voice Prompt Option is installed), or simply with Tone Prompts.

The factory default password is "**1 2 3 4**", and this password can be changed to any DTMF or numerical value up to 10 characters in length. To change the password, first enter the programming mode by entering '*** 9 9**". If passwords are currently enabled, it will be necessary to enter the correct password to continue programming. From the programming mode, enter "*** 1 x x x #**" where "x x x" is the new password, up to 10 characters long. Next enter "* #" to leave the programming mode.

3.7.8 INACTIVITY DISCONNECT TIMER

The inactivity disconnect timer ensures that the system does not remain locked up on a completed call if system users forget to or are unable to terminate a call by normal means. The inactivity timer samples audio from both the radio and the telephone. If no activity is detected for a time equal to the Inactivity Disconnect Timer setting, the RTU-292 will notify the users by three short beeps that they have five seconds to respond or the call will be terminated. If either the radio user or the PSTN caller initiates activity within 5 seconds of the warning beeps, the timer is reset.

Inactivity Disconnect Timer lengths of 2 minutes to 120 minutes (or disabled) are available. Enter "*** 9 9**" to enter the programming mode, then "*** 2 x**" to set the timer. The value of x sets the timer length. See Table 3-2 for the list of timer durations. The value of x = 0 will disable the timer so that the connection may be maintained indefinitely. Unless a permanent connection is required, disabling the timer is not recommended. If the telephone caller does not correctly terminate the call, the unit can become locked up in the connected state. Once the desired timer length is set, enter "* #" to leave the programming mode.

3.7.9 CALLING TIMER

The Calling Timer determines how long the RTU-292 will attempt to place a telephone call. Once the timer expires, the RTU-292 terminates the attempt. Note that if the unit detects a busy signal or other feedback that indicates that the call cannot be placed, the attempt will be immediately terminated.

Two Calling Timer lengths, either 30 seconds or 1 minute, are available. Enter "*** 9 9**" to enter the programming mode, then "* 3 x" to set the timer. The value of x sets the Calling Timer duration. "*** 3 0**" sets the Calling Timer to the factory default length of 30 seconds. "*** 3 1**" sets the timer to 1 minute. Once the desired timer length is set, enter "* #" to leave the programming mode.

3.7.10 USING THE RTU-292 SPEED DIAL FEATURE

The RTU-292 has the ability of storing 99 telephone numbers in non-volatile memory. These numbers may be used when making a call using via UHF/VHF radio with a DTMF keypad. To use the speed dial feature, simply enter the speed dial number instead of a telephone number. Note: The Voice Prompt Option is recommended if the speed dial feature is used, but is not required. Voice prompts are essential in assisting the user in programming, reviewing, and using the speed dial feature.

3.7.10.1 Programming the Speed Dial Directory

These numbers are programmed by first putting the RTU-292 into the programming mode. To enter this mode, enter the DTMF command "*** 9 9**". The RTU-292 will respond with its "*READY*" prompt.

1. The user next enters the command "*** 4"** on the keypad of the RTU-292*, the Local Phone telephone set or the keypad of a connected telephone.

   *See 3.7.6 for special instructions if the front panel keypad is used.
2. The RTU-292 gives the prompt "*ENTER SPEED DIAL LOCATION*".
3. The user enters two digits for the speed dial location. A leading 0 is used for locations 1-9. For example, when the user is programming speed dial location number 1, he must enter "**01**".
4. The RTU-292 gives the prompt "*ENTER PHONE NUMBER*".
5. The user enters the digits of the phone number. When complete the user enters a "#".
6. The user may review the contents of the speed dial directory by entering the command "*** 5**".
7. When programming is complete, enter the "*** #**" sequence to take the RTU-292 out of programming mode.

3.7.10.2 Using the Speed Dial Feature

Operation is the same as standard, except when queried for a phone number by the RTU-292, the radio enters the speed dial location instead of the telephone number. For example to call the number stored at speed dial location six, the user enters *** 0 6 #** (star zero six pound). All single digit speed dial numbers must be proceeded by a zero as in example provided.

3.7.11 OPTIONAL 4 WIRE OPERATION

The unit can be set to operate with a four wire device instead of a standard 2 wire phone. The additional I/O is handled by header J6 on the main PCB. The STU-III option makes use of this capability. To put the RTU-292, first place the unit in programming mode with the *99 command. Then enter the *** 6 1** DTMF command. To return to 2 wire operation, enter *** 6 0**. To query the unit for its current setting, enter *** 6 #** (requires voice prompt option to hear response from unit). See Table 3-2. When programming is complete, enter *** #** to exit the programming mode.

3.8 FACTORY RESET

It's possible to perform a Factory Reset that will return all user-programmable parameters (other than the speed dial directory) to the initial factory default settings. This includes the system password, the Inactivity Disconnect and Calling Timers, etc.

To perform a Factory Reset, hold the 0 (zero) key in on the front panel keypad while the main power is turned on. After the unit has powered up, let go of the 0 key.

3.9 SPEED DIAL RESET

A Speed Dial Reset completely erases the information in the speed dial directory.

To perform a Speed Dial Reset, hold the 1 (one) key in on the front panel keypad while the main power is turned on. After the unit has powered up, let go of the 1 key.

4 RTU-292 Theory Of Operation

4.1 GENERAL

This section gives enough detail of the theory of operation of the RTU-292 audio and power supply sections to allow them to be troubleshot in the field. The same level of detail is not supplied for the DSP module and the CPU portion as they are considered impractical to field troubleshoot because of the specialized knowledge and test equipment required. If a fault is suspected in these sections, factory repair is required.

4.2 FRONT PANEL BUTTONS AND INDICATORS

Figure 8-1 is a schematic of the RTU-292 front panel. The control pushbuttons and associated LEDs are arranged in three separate PC board assemblies: the Tel Line Switch Assembly, the Handset Switch Assembly, and the Speaker Switch Assembly. Signals from each of these assemblies are combined into one ribbon cable that plugs into the Main Board at J3. Each control pushbutton switches +5V onto its control line when ON and open circuit when OFF. Pulldown resistors on each of the control inputs pull the line to ground when its button is OFF. The buttons are read by the processor on the Main Board. The processor, not the pushbuttons, controls the unit's audio gates as well as the front panel LEDs.

4.3 MAIN BOARD

Main Board Circuitry is detailed in Figure 8-2.

4.3.1 AUDIO BUS ARRANGEMENT

The audio switching is bus oriented. Each major bus is named after the output signal that it carries for distribution with the major buses as follows:

Signal Name	Source	Comment
TEL	U8C-11	Telephone Receive Signal.
MIC	U15B-7	Amplified/AGC'd Microphone Signal.
RXA	U22D-6	Amplified Radio Receiver Signal.
RING	U33A-2	Telephone Ringer Signal.
DTMF	J13-32	DTMF Dialer Output.

The bus signals are each gain-leveled to a nominal 0 dBm (0.775V rms) average amplitude, except for the hybrid in/out signals, which are usually at a –12 dBm (0.194V rms). The bus signals are routed to various destinations through analog gates controlled by signals from the CPU on the Main Board.

4.3.2 TELEPHONE INTERFACE CIRCUITS

4.3.2.1 Telephone Send Circuits

Amplifier U1B generates the Telephone Send signal (the audio which is sent down the phone line from the RTU-292). U1B is configured as an inverting stage with its gain set by a combination of input and feedback resistors selected by analog gates U4A through U4D. The send level calibration assumes that there is a 0 dBm signal level at the input to U1B on U8B-15. (If the setup is done properly, this is assured by the PEAK LED, which is set to flash at a peak level equivalent to 0 dBm.) The calibration is such that when a 600 Ohm load is placed on the telephone line terminals, the signal level at TP3 will be 3 dB lower than stated send signal level. This 3 dB margin allows some headroom for peaks in the program material without overdriving the phone line.

Resistor R1 establishes the output impedance of the telephone send amplifier, and (in parallel with R11) determines also the terminating impedance for the phone line.

Zener diodes CR2 and CR3 protect the circuitry in the RTU-292 from high voltage spikes on the phone line. 1:1 Audio transformer T1 couples the RTU-292 to the phone line. Capacitor C1 compensates the leakage inductance of the transformer to produce a flat frequency response. Capacitor C2 keeps the phone line DC current out of T1. Instead of using the secondary of T1 to sink the phone line DC holding current, an active constant current load is used which consists of CR1, Q1 and Q2 and associated components.

The constant current load provides a means of sinking the DC holding current from the phone line so that the RTU-292 will seize and hold the line. Bridge CR1 corrects the DC polarity so that a positive voltage is always applied to the collector of Q1, eliminating the need to be concerned about the polarity of the phone line. Transistors Q1 and Q2 are connected as a constant current load and C3 insures that the load does not respond to audio frequencies, so that the load appears as a very high AC impedance in parallel with the transformer secondary. When the load is in operation, the DC voltage from TP1 to TP2 will be approximately 4V to 8V.

The phone line connections are made via J1 or the terminal block J12 to relay K1, which, when the power is off or the unit is in Disconnect, disconnects the phone line from the internal circuitry. Components L1, L2 and associated capacitors form Pi-Section filters to remove RF from the normally unshielded phone lines. RV1 is a metal-oxide varistor that limits high voltage transients that might appear on the telephone line.

4.3.2.2 Telephone Receive Circuits

Amplifier U2A is the telephone receive amplifier, which is arranged as a non inverting stage and gets its input via R11 from transformer T1. U2B is gain adjustable via a combination of input and feedback resistors selected by analog gates U6A - U6D. The gain distribution is set so that, with a 600 Ohm load on the telephone line terminals, the PSTN level stated in the Input Signal Level Table will produce a -12 dBm signal at U2B-7.

Note that the telephone send signal appears mixed with the telephone receive signal at U2A-1. Furthermore, the amount of send signal mixed in depends on the telephone line impedance, and is also frequency dependent. It is the job of the DSP hybrid to remove the telephone send signal and pass only the telephone receive signal to the transmitter output circuits. The inputs to the adaptive hybrid are A/D 2 (U1A-1) and A/D 1 (U2B-7). The DSP hybrid essentially subtracts

the signal at A/D 2 from that at A/D 1 and the difference appears on D/A 1, which is named TEL after passing through gate U8C.

4.3.2.3 Ring Detector and Tone Ringer

Integrated circuit U7 is an optocoupler that senses the ring voltage on the telephone line. When a ring voltage is detected, U7-5 goes low with the frequency and cadence of the ring voltage. This signal is fed to the DSP module on J14-28, where the DSP strips off the ring frequency and passes the a signal with the ring cadence alone on J14-7 to the ring tone generator circuit.

Circuits U31 and U32 form a tone ringer to provide the audible ring signal for the RTU-292's speaker. U32 is a 10 Hz oscillator which frequency-modulates oscillator U31 via R41. Because of the modulation by U32, U31 switches between about 1000 Hz and 800 Hz at a 10 Hz rate, producing a "warble" tone. Normally, both oscillators are held reset by J14-7. When ring voltage is detected, J14-7 goes high, allowing the oscillators to run.

4.3.3 RADIO INTERFACE CIRCUITS

4.3.3.1 Receiver Input Amplifier

The input from a receiver is connected to P1-1 and P1-6. Jumper JP1 selects whether the input is balanced or unbalanced. In Balanced position, the signal is fed to the primary of transformer T2. In unbalanced position, the signal is fed to U20A through R110 and R111, which provides a unity gain, AC-coupled input of 47k impedance. R110 and C59 are in the circuit for RF decoupling. The secondary of T2 is connected to amplifier U20A, configured as a high input impedance unity gain amplifier. In balanced position, Jumper JP2 determines the input impedance of the receiver input. In low impedance position, R112 is placed across the secondary of T2 to make a 600 ohm termination. In high input impedance position, R112 is removed from the circuit, leaving only the 47k Ohm resistor R113. The output of U20A is fed to amplifier U20B, a gain adjustable amplifier which sets the receiver input signal level. The output of U20B is nominally at the level of -10dBm, and the adjustment range of R116 allows -10 dBm to be produced at U20B-7 with input signals in the range of -40dBm to +10dBm.

4.3.3.2 Transmitter Audio Output

Gain-adjustable amplifier U21A provides the audio output to the transmitter. The adjustment range of R133 is set so that with 0 dBm audio at U21B-7, the signal on the secondary of T3 (loaded with 600 Ohms) can be adjusted between +10dBm and -40 dBm. Amplifier U21A gets its input signal from mixer amplifier U21B, which is fed by analog gates U22A, B, C and U23A and U23B. These gates route prompt, DTMF, microphone and telephone input signals to the transmitter output.

4.3.3.3 Keying Circuits

The key relay, K2, provides two isolated outputs. Signals /Key Out and KB are the normally open contacts of both halves of K2. These signals are routed to P1-4 and P1-9 and are shorted to ground when the key relay is energized.

Signals from /KEY IN and CPU KEY are summed in U24B and drive key relay driver Q4. Transistor Q5 is driven by the VOX key output from the DSP. U24A ensures that the microphone key switch will not function unless enabled by the CPU board with the MIC KEY EN signal.

4.3.3.4 DTMF Detector

Circuit U25 is a DTMF detector/decoder dedicated to listening for DTMF signals from the radio. Its input is connected to the leveled radio receive signal at U20B-7. The DTMF data is read by the processor. A separate DTMF detector running in DSP software listens for DTMF from the telephone line.

4.3.3.5 FSK Modem

Circuit U26 is a hardware FSK modem that listens for FSK signals from the radio at U20B-7, and can send FSK signals to the radio from U26-17.

4.3.4 HANDSET/ SPEAKER INTERFACE

4.3.4.1 Microphone Circuit

The handset is connected to J7, with the mic signal appearing on J7-5. Resistors R50 and R51 provide bias current for the electret or carbon microphone element (electret is standard). Components L3, C20 and L4, C23 provide filtering against conducted RF. Amplifier U13A is the microphone preamplifier; its output U13A-1 drives the ALC circuit composed of U14A and U13B. The ALC holds the output level at U13B-7 to about -9dBm over a 30 dB input range. Amplifier U15B boosts the mic signal level to about 0dBm to drive the MIC bus. Resistor R64 feeds some of the mic signal into the handset earpiece as "sidetone", so the earpiece doesn't sound dead.

4.3.4.2 Speaker and Headphone Circuits

The signals that drive the speaker are selected by analog gates U18A, U18B, and U18C; and are mixed in amplifier U16A. The output on U16A-1 is fed to the top end of the speaker volume potentiometer on the front panel. The wiper of the volume pot is fed to the speaker driver U17 through R89. The ring signal from the tone ringer is mixed via R88 so that it bypasses the volume pot. (Its amplitude is set separately by R156).

Headphones and handset signals are selected by analog gates U19A, U19B, and U19C; and mixed in amplifier U16B. Output U16B-7 is applied to the top end of the headphones volume pot on the front panel. The signal from the pot wiper is fed to amplifier U15A through R65. The output of U15A drives the handset earpiece through R67 and the headphone jack through R68.

4.3.5 DSP MODULE

The DSP hardware circuitry is detailed in Figure 8-3. The general purpose of the DSP hardware is to convert analog signals to the digital domain, operate on and manipulate these signals digitally using the DSP chip, then convert the result back to analog. In this way, it is possible to implement functions such as the adaptive hybrid, which would be impossible or impractical to implement using purely analog techniques. In addition to the DSP chip itself, the module contains two analog interface chips, static RAM for audio storage and delay, and a program flash memory chip.

4.3.6 DSP SOFTWARE

The DSP software is contained in a FLASH memory chip located on the DSP module. All of the following functions are implemented in software by the DSP

4.3.6.1 Adaptive Hybrid

The adaptive hybrid is the central function of the RTU-292. Its purpose is to separate and isolate the telephone receive signal by subtracting the telephone send signal from the mixed telephone send and receive signals. If this subtraction is done perfectly, the telephone receive signal is completely isolated. The digital adaptive hybrid in the RTU-292, while not achieving perfection, comes close, and gives as much as 40 dB isolation when measured with a broadband noise source. Comparable isolation for a conventional hybrid would likely be only 10 dB, measured in the same way.

The adaptive hybrid samples the telephone send signal at A/D 2, samples the mixed telephone send and receive signals on A/D 1, and outputs the isolated telephone receive signal to the transmitter output amplifier on D/A 1.

The hybrid function also contains a threshold detector that allows VOX operation when balance has been achieved.

4.3.6.2 Noise Generator

A pseudo-random noise generator is implemented to speed hybrid adaptation. During the adaptation cycle, the input receiver audio is switched off by gate U8C, and the noise generator switched on at gate U8A. The wide bandwidth of the noise assures that the hybrid is adapted over the full audio bandwidth.

4.3.6.3 Peak Detector

A peak detector monitors the receive audio bus and signals at A/D 2 to flash the PEAK LED on audio peaks which exceed 0 dBm. This function aids in setting up the RTU-292 with the proper audio levels.

4.3.6.4 VOX

A VOX (Voice Operated Xmit) function looks at the output of the adaptive hybrid and triggers if the audio exceeds a preset level. Once triggered, it stays active for a short time to prevent VOX drop out on pauses between syllables. This is called Hang Time, and is adjustable via Option Switch SW2-6. The VOX sensitivity is adjustable via Option Switches SW2-4 and SW2-5.

4.3.6.5 Audio Delay

The output of the adaptive hybrid is delayed before being output to the transmitter output amplifier. The purpose of the delay is to insure that the transmitter is keyed a sufficient time before the audio arrives so that the entire first speech syllable is transmitted.

4.3.6.6 DTMF Detector

A DTMF detector is implemented in DSP software that listens to the telephone line signal after the hybrid.

4.3.6.7 DTMF Generator

A DTMF generator is implemented in DSP software that outputs DTMF digits to the telephone line for dialing. The output is from J13-32 DTMF, which is routed to gate U9D so it may be mixed with the signal to be sent to the telephone line in U1A.

4.3.7 POWER SUPPLY

The power supply is detailed in page 8 of 9, Figure 8-2. It supplies regulated DC voltages of +5V, +12V, -5V, and -12V from both AC and DC inputs.

4.3.7.1 AC Power Supply

The AC power supply is a conventional passive regulator supply with a small PC mounted line transformer, T4 which has dual primaries for 115 or 230 VAC operation, and has dual 15 VAC secondaries which are wired in parallel. T4 and bridge CR36 along with capacitors C120 and C121 are configured as a positive full wave circuit supplying unregulated +BUS voltage (about 20VDC) to the +12V and two +5V regulators. One +5V regulator, U72, feeds the RTU-292 standard circuits. The other regulator, U71, feeds only the assemblies on the option tray. The positive regulators are standard three-terminal types, using a finned heatsink for cooling.

The negative voltage is supplied by switching regulator U73, which converts the +BUS voltage to -12V adjustable by R212.

4.3.7.2 DC Power Supply

The DC power supply allows the RTU-292 to be powered from either a +12V or +24V DC source as well as the standard AC supply line input. Slide switch S6 configures the supply for either +12V or +24/28V operation. This circuitry is reverse-polarity protected by schottky diodes in series with the voltage lines.

If sufficient AC and DC power are simultaneously applied, the unit will draw power from the AC line only. Its auto take-over feature will draw DC power only if the AC line sags.

The DC supply input is filtered by choke L2 and by capacitors C50 and C51. If the DC input is +12V, this filtered supply feeds the +BUS directly via CR34, and supplies +12V around U70 via CR33. It also supplies voltage directly to the inputs of the +5V regulators through CR39 and R213, and through CR40 and R214. If the DC input is +24/28V, the +BUS is fed through emitter follower Q24, which keeps the bus voltage from rising above about +24V when input voltages of 24V to 32V are used.

4.3.8 CPU

The CPU portion of the main board controls all functions of the RTU-292. This board uses the front panel switches and keypad, as well as the RS-232 serial communications port and signals received over the telephone as control inputs. The Main board lights front panel LEDs to display its current status, and controls the audio gates on the audio portion of the main board to route signals to their correct destinations. Refer to pages 5, 6 & 7 of Figure 8-2.

The RTU-292 is controlled by microprocessor U46. The program that runs U46 resides in EPROM U40. The unit's current status is stored in EEPROM U41. Octal latch U39 creates address lines A0 through A7 from the data bus and the AS control line. Voltage supervisor U45 ensures that the microprocessor turns off and on in an orderly manner when power is turned off and on or during power glitches. RS-232 driver U37 interfaces the microprocessor with the serial communications port. The /IRQ (interrupt request) signal generated by portions of U47 and U48 informs the processor when the keypad is under use or a DTMF signal has been detected by the Audio Board.

Most of the rest of the circuitry comprises I/O devices. U43 and U44 create the chip selects required to control these devices. U38 sends commands to the optional Voice Prompt Board.

Bus drivers U60 and U61 are the input devices for the front panel switches; latches U62 and U63 light the front panel LEDs. Latches U50 through U53 send control signals mainly to the audio circuit sections. U56 and U57 send inputs to the data bus; U54 and U55 read Option switches SW1 and SW2. Keypad decoder chip U59 provides the keyboard interrupt and translates keypad closures before sending them onto the data bus via latch U58.

4.3.9 PROMPT TONE GENERATOR

Timer IC U30 can create tones of 500, 600, 750 or 1kHz, depending on the states of control signals from the CPU Board DT0 and DT1. The volume of these prompts may be adjusted via potentiometer R158. U33B, U33C, and U33D route either tone prompt or voice prompt signals to the circuitry; controlled by the T/V signal from the CPU.

4.4 OPTION INTERFACE BOARD

This board contains the basic databus, power audio, and control lines to operate the various options that may be installed on the unit on the options tray. See figure 8-4.

4.5 VOICE PROMPT OPTION

The Voice Prompt Option outputs prerecorded voice prompts into the telephone send signal or into the radio transmit audio output from the RTU-292. See figure 8-5.

4.5.1 SPEECH PROCESSOR

The heart of the voice prompt option board is the speech processor chip, U7. This chip is an ADPCM (Adaptive Pulse Code Modulation) processor containing built-in A/D and D/A, and can be used for recording as well as playback. The digitized voice prompts are contained in EPROM U5, which U7 accesses via data bus AD. The prompt analog audio is output on U7-28 and is passed through amplifiers U9 and U10. These amplifiers are arranged as a five-pole active low-pass filter which removes remnants of the 8 kHz sampling frequency from the output audio.

4.5.2 CONTROL PROCESSOR

The control microprocessor is the 68HC11A0, an 8-bit processor running at 8 MHz with a basic instruction cycle time of 2 microseconds. There is some I/O from the processor chip itself from Port D (pins 20 to 25) and Port A (pins 27 to 34) which controls the Audio Processor chip. The control input to the board is to Port E (Pins 43 to 50) from connector J1. The lower eight bits of the address bus are separated from the data bus by address latch U2.

EPROM U4 is the program memory, a 27C256 providing 16k of address space.

Chip select signals for the various I/O are provided by PEEL U6.

Several devices on the CPU board use a 3.58 MHz clock signal that is provided by crystal Y2 and gates U12B and U12C.

U3 is a reset generator that ensures an orderly power-up sequence for the microprocessor and associated components. It senses the voltage on the +5V line and generates a reset while the voltage is below approximately 4.55V. As the voltage rises above the threshold, a delay is generated by C4 to insure processor clock stability before operation commences. Resistor R5 prevents resetting on short spikes on the 5V line.

4.5.3 VOICE PROMPT SOFTWARE

The voice prompt board software receives the prompt number command through J1 and translates it into the prompt address in EPROM U5.

4.6 LOCAL PHONE OPTION

The Local Phone Option allows a standard telephone set to be plugged into an RJ-11C modular jack at the rear of the RTU-292. This telephone set may then be used to place or receive calls via the RTU-292 to the PSTN or an associated radio. The Local Phone Option can also be used to control the RTU-292 remotely, changing various configuration options (see section 3.7).

4.6.1 INTERFACE CIRCUITRY

Amplifier U3A generates the local telephone send signal. This mixing amplifier accepts inputs from the dial/busy generators U5 and U6, and from the local phone send line. This line from the audio board, may be the audio from the telephone lines, prompt tones, receiver audio, sidetone audio or DTMF tones, depending on the state of control gates on the audio board. The gain is set to produce an approx. -9 dBm level at U3A-1. U3B is configured as a conventional active hybrid. The local phone send signal is sent to U3B via R8 and R35. The combination send plus receive signal reaches U3B via R7. The send signal is subtracted from the send plus receive signal, leaving only the receive signal at the output of U3B.

4.6.2 DIAL/BUSY GENERATORS

Dial/Busy signals are composed of two tones, so a pair of frequency sources, U5 and U6, are required. Each of these 555 timer ICs provides a square wave output. R30 and C10 set the frequency of U5 to 460 Hz. The frequency of U6 is 620 Hz when Q2 is off, set by R24 and C11. When commanded by the CPU Board, Q2 turns on, placing C12 in parallel with C11. This cuts the frequency of U6 to 350 Hz.

The CPU Board normally holds the timers off, but when a high signal is sent on the DTONE line, U5 and U6 turn on. Their square wave outputs are smoothed by the RC filter networks made up of R31, R34, and C18 and R32, R33, and C17.

4.6.3 LOCAL TELEPHONE LINE INTERFACE

Tip and Ring signals are brought to the board on J1. Varistor RV1 limits transients that may appear on the local phone line. The silent ring trip circuit will sense a voltage drop across R22 if the local phone is taken offhook while it is not ringing (K1 will be in the non-energized state shown in the schematic). This voltage drop will turn on Q5, which signals the offhook condition to the CPU board via J1-5.

The local phone is made to ring by the CPU Board when it J1-9 is brought high, turning on Q1 and energizing K1. K1 switches the ring generator U4 onto the telephone line. The ring cadence is controlled by the CPU Board via the RING signal at J1-2. If the telephone goes offhook during the ring cycle, the voltage drop across R18 turns on Q3, pulling J1-5 high.

Diodes CR1 and CR2 provide transient suppression for the audio circuitry.

5 Remote Control Protocol

5.1 GENERAL

Included in this section are instructions for controlling the RTU-292 via its RS-232 serial communications port. The protocol listed in this section is the standard command set that accompanies the standard software version. If an RTU-292 is shipped with custom software that employs different commands, a set of special version notes, including a modified protocol, will be shipped with the unit.

5.2 RS-232 REMOTE CONTROL OVERVIEW

The RTU-292 may be controlled and monitored remotely via its RS-232 interface. The RS-232 interface consists of RX, TX and Ground only. Hardware and software handshaking are not used. **The serial format is 8 data bits, 1 stop bit, and no parity**. The baud rate is controlled by setting DIP switches on the CPU card. Available baud rates are 300, 1200, 2400 and 9600.

All commands to the RTU-292 and responses sent from the RTU-292 use standard ASCII characters. All remote commands are terminated with a carriage return (CR) and (optionally) a line feed (LF). Status information returned from the RTU-292 will always be preceded by a "%" character, and is also terminated by a CR. This protocol allows control and monitoring of the RTU-292 via a dumb terminal or a computer program. The commands issued to the RTU-292 are not case sensitive.

5.3 COMMANDS SENT TO THE RTU-292

The following section describes the operation of each of the RTU-292 remote control commands. All commands have the format:

cmd <data> <data> ... <data> <CR>

The first string is the **command** string. The command string must not be preceded by any space characters. There is at least one blank (space) character after the command string. Any data that is required by the command follows next. Multiple data sections are delimited by at least one space. Most commands require that data be presented in a specific order. Finally the command is terminated by a Carriage Return character (CR). Line feed characters may be included after the Carriage Return, but they are not necessary.

Examples:

Turn on the Speaker-Radio audio:
SPKR_RAD ON <CR>

Get the firmware revision number:
VER <CR>

When a command is sent to the RTU-292 it is buffered up and acted on as soon as possible. Once the command has been executed, the RTU-292 will return a "Status" response. The format of this status response is explained in greater detail in the section 5.4, "Status Returned From The RTU-292". ***The RTU-292 is designed to act on one command at a time. The user must wait for a response from a given command before entering the next command***.

Table 5-1 Command Summary

Null Command	**<CR>** …….
Auto Answer Command	**AUTO_ANS** <ON|OFF|?> <CR> …….
Audible Ring Command	**AUD_RING** <ON|OFF|?> <CR> ……..
Date Command	**DATE** <ddmmyy> <CR> ……
Dial Command	**DIAL** <OPER|LP|number string> <CR>
Disconnect Command	**DISC** <CR> …….
Generate DTMF command	**+DTMF** <number string> <CR> …….
Handset Phone Command	**HS_PH** <ON|OFF|?> <CR> …….
Handset Radio Command	**HS_RAD** <ON|OFF|?> <CR> ……..
Speaker Phone Command	**SPKR_PH** <ON|OFF|?> <CR> ……
Speaker Radio Command	**SPKR_RAD** <ON|OFF|?> <CR> …….
Speed Dial Command	**SD** <nn|ALL> <num|.|?> <CR>
Tel-Line Phone Command	**TEL_LINE_PH** <ON|OFF|?> <CR> ….
Tel-Line Radio Command	**TEL_LINE_RAD** <ON|OFF|?> <CR> ..
Time Command	**TIME** <hhmmss> <CR> ……..…
Software Version Command	**VER** <CR> ……..

5.3.1 NULL Command

<CR>

This command may be used as a quick way to insure that RS-232 communication with the RTU-292 is functioning. The command has no parameters.

Expected Response: NULL Response.

Example:

```
  <CR>          ; Command sent to the RTU-292.
% E0 <CR>       ; Status returned from the RTU-292.
```

5.3.2 Auto Answer Command

AUTO_ANS <ON|OFF|?> <CR>

This command is to enable, disable or query the current status of Auto Answer.

Expected Response: Auto Answer Response.

Examples:

```
AUTO_ANS ON  <CR>     ; Command to enable Auto Answer.
%AUTO_ANS  ON E0 <CR> ; Status returned showing that Auto Answer is on.

AUTO_ANS  ?  <CR>           ; Command requesting the status of Auto Answer.
%AUTO_ANS  OFF E0 <CR> ; Status returned showing that Auto Answer is not enabled.
```

5.3.3 Audible Ring Command

AUD_RING <ON|OFF|?> <CR>

This command is to enable, disable or query the current status of Audible Ring.

Expected Response: Audible Ring Response.

Examples:

```
AUD_RING ON  <CR>     ; Command to enable the audible ring.
%AUD_RING  ON E0 <CR> ; Status returned showing that audible ring is on.

AUD_RING  ?  <CR>           ; Command requesting the status of audible ring.
%AUD_RING  OFF E0 <CR> ; Status returned showing that audible ring is disabled.
```

5.3.4 Date Command

DATE <ddmmyy> <CR>

This command is used to check or set the date on the RTU-292 internal clock. If no parameters are given the command simply returns the time/date. The parameter format is day (01-31), month (01-12), year (00-99). ***Note: the Call Logging Feature must be enabled before use. See 3.7.12.***
Expected Response: Time/Date Response.

Examples:

DATE <CR> ; Command requesting the current time and date from the RTU-292.
%01-MAR-98 11:05:20 E0 <CR> ; Status returned indicating that the date is March 1st '98, and the time is ;11:05 and 20 seconds in the morning.

DATE 051297 <CR> ; Command to set the date to December 5, '97.
%05-DEC-97 14:18:30 E0 <CR> ; Status returned indicating that the date is December 5th '97, and the time is ; 2:18 and 30 seconds in the afternoon.

5.3.5 Dial Command

DIAL <OPER|LP|number string> <CR>

This command is used to dial a phone number via PSTN line. ***Note: the RTU-292 must be on-hook to use this command.***

The parameter **OPER** may be substituted for the number. In this case the call will be placed to the front panel of the RTU-292. Likewise the parameter **LP** may also be substituted for the number. This will cause the call to be routed to the Local Phone option (if installed).

Valid digits for the number string are '0'-'9', the characters * # and ','. The comma character is used to produce a 2 second pause while dialing. No spaces are allowed in the number string.

Expected Response: Dial Response.

Examples:

DIAL 5551234 <CR> ; Command requesting the RTU-292 to dial the number 5551234.
%DIAL 5551234 E0 <CR> ; Status returned indicating that the number 5551234 was dialed.

DIAL OPER <CR> ; Command requesting the RTU-292 to call the Operator (front panel).
%DIAL OPER E0 <CR> ; Status returned indicating that the call was placed to the Operator.

DIAL LP <CR> ; Command requesting the RTU-292 to call the Local Phone option.
%DIAL LP E4 <CR> ; Error status returned indicating that the Local Phone option is not installed in this unit.

DIAL 5551234 <CR> ; Command requesting the RTU-292 to dial the number 5551234.
%DIAL 5551234 E5 <CR> ; Status returned indicating that the number could not be dialed because the unit is ; already off-hook.

5.3.6 Disconnect Command

DISC <CR>

This command is used to drop the PSTN connections.

Expected Response: Disconnect Response.

Examples:

DISC <CR> ; Command requesting that the PSTN be disconnected.
%DISC E0 <CR> ; Status returned indicating that the PSTN was disconnected.

5.3.7 DTMF Command

DTMF <number string> <CR>

This command is used to generate DTMF tones via the PSTN line. This is useful when the call involves the use of a calling card or automated phone system. ***Note: if the PSTN must already be off-hook to use this command. This is done by using the DIAL command or the TEL-LINE-PH command.***

Valid digits for the number string are '0'-'9', the characters * # and ','. The comma character is used to produce a 2 second pause. No spaces are allowed in the number string.

Expected Response: DTMF Response.

Examples:

DTMF 1234 <CR> ; Command requesting the RTU-292 to generate DTMF for the digits 1 2 3 and 4.
%DTMF 1234 E0 <CR> ; Status returned indicating that DTMF for the number(s) 1234 was generated.

DTMF 1234 <CR> ; Command requesting the RTU-292 to generate DTMF for the digits 1 2 3 and 4.
%DTMF 1234 E6 <CR> ; Status returned indicating that this command can not be used at this time. In this case ; the RTU-292 is probably still on-hook.

5.3.8 Handset Phone Command

HS_PH <ON|OFF|?> <CR>

This command is to enable, disable or query the current status of Handset Phone

Expected Response: Handset Phone Response.

Examples:

HS_PH ON <CR> ; Command to enable the Handset Phone path.
%HS_PH ON E0 <CR> ; Status returned showing that the Handset Phone path is enabled.

HS_PH ? <CR> ; Command requesting the status of the Handset Phone path.
%HS_PH OFF E0 <CR> ; Status returned showing that Handset Phone is disabled.

5.3.9 Handset Radio Command

HS_RAD <ON|OFF|?> <CR>

This command is to enable, disable or query the current status of Handset Radio.

Expected Response: Handset Radio Response.

Examples:

HS_RAD ON <CR> ; Command to enable the Handset Radio path.
%HS_RAD ON E0 <CR> ; Status returned showing that the Handset Radio path is enabled.

HS_RAD ? <CR> ; Command requesting the status of the Handset Radio path.
%HS_RAD OFF E0 <CR> ; Status returned showing that Handset Radio is disabled.

5.3.10 Speaker Phone Command

SPKR_PH <ON|OFF|?> <CR>

This command is to enable, disable or query the current status of the Speaker Phone path.

Expected Response: Speaker Phone Response.

Examples:

SPKR_PH ON <CR> ; Command to enable the Speaker Phone path.
%SPKR_PH ON E0 <CR> ; Status returned showing that the Speaker Phone path is enabled.

SPKR_PH ? <CR> ; Command requesting the status of the Speaker Phone path.
%SPKR_PH OFF E0 <CR> ; Status returned showing that Speaker Phone is disabled.

5.3.11 Speaker Radio Command

SPKR_RAD <ON|OFF|?> <CR>

This command is to enable, disable or query the current status of the Speaker Radio path.

Expected Response: Speaker Radio Response.

Examples:

SPKR_RAD ON <CR> ; Command to enable the Speaker Radio path.
%SPKR_RAD ON E0 <CR> ; Status returned showing that the Speaker Radio path is enabled.

SPKR_RAD ? <CR> ; Command requesting the status of the Speaker Radio path.
%SPKR_RAD OFF E0 <CR> ; Status returned showing that Speaker Radio is disabled.

5.3.12 Speed Dial Command

SD <nn|ALL> <num|.|?> <CR>

This command is used to program or review data in speed dial memory. There are 99 locations in speed dial memory. These range from 1 to 99, with location 0 being used by the system as "scratch pad" memory. The keyword "ALL" may be used in place of the speed dial location to refer to all of speed dial memory. The second argument allows the speed dial location to be programmed to the given number string. Valid phone numbers contain the ASCII Text digits "0"-"9" as well as "*" and "#". If a period is entered in place of the phone number data, the speed dial location will be erased. The speed dial location can be reviewed by entering a "?" in place of the phone number.

The phone number may contain up to 25 digits.

Expected Response: Speed Dial Response.

Examples:

SD 1 5551212 <CR> ; Command to program location 1 with the phone number 555-1212.
%SD 1 5551212 E0 <CR> ; Status showing that location 1 is programmed with the number 555-1212.

SD 21 ? <CR> ; Command requesting the contents of speed dial location 21.
%SD 21 5551212 E0 <CR> ; Status showing that location 21 is programmed with the number 555-1212.

SD ALL . <CR> ; Command to delete all locations in speed dial memory.
%SD 1 is empty. E0 <CR> ; Each speed dial location is reported as empty.
%SD 2 is empty. E0 <CR>
…
%SD 99 is empty. E0 <CR>

5.3.13 Tel-Line Phone Command

TEL_LINE_PH <ON|OFF|?> <CR>

This command is to enable, disable or query the current status of Tel-Line Phone. Note that enabling Tel-Line Phone will put the PSTN in an Off-Hook status. Disabling Tel-Line Phone will only put the PSTN back on hook if Tel-Line Radio is also disabled. To quickly disconnect the PSTN use the DISC command.

Expected Response: Tel-Line Phone Response.

Examples:

TEL_LINE_PH ON <CR> ; Command to enable the Tel-Line Phone path.
%TEL_LINE_PH ON E0 <CR> ; Status returned showing that Tel-Line Phone is enabled.

TEL_LINE_PH ? <CR> ; Command requesting the status Tel-Line Phone.
%TEL_LINE_PH OFF E0 <CR> ; Status returned showing that Tel-Line Phone is disabled.

5.3.14 Tel-Line Radio Command

TEL_LINE_RAD <ON|OFF|?> <CR>

This command is to enable, disable or query the current status of Tel-Line Radio. Note that enabling Tel-Line Radio will put the PSTN in an Off-Hook status and cause the DSP telephone hybrid to adapt. Disabling Tel-Line Radio will only put the PSTN back on hook if Tel-Line Phone is also disabled. To quickly disconnect the PSTN use the DISC command.

Expected Response: Tel-Line Radio Response.

Examples:

TEL_LINE_RAD ON <CR> ; Command to enable the Tel-Line Radio path.
%TEL_LINE_RAD ON E0 <CR> ; Status returned showing that Tel-Line Radio is enabled.

TEL_LINE_RAD ? <CR> ; Command requesting the status Tel-Line Radio.
%TEL_LINE_RAD OFF E0 <CR> ; Status returned showing that Tel-Line Radio is disabled.

5.3.15 Time Command

TIME <hhmmss> <CR>

This command is used to check or set the time on the RTU-292 internal clock. If no parameters are given the command simply returns the time/date. The parameter format is hour (00-23), minutes (00-59), seconds (00-59). The time is set and displayed in 24-hour format. ***Note: the Call Logging Feature must be enabled before use. See 3.7.12.***
.

Expected Response: Time/Date Response.

Examples:

TIME <CR> ; Command requesting the current time and date from the RTU-292.
%01-MAR-98 11:05:20 E0 <CR> ; Status returned indicating that the date is March 1st '98, and the time is ;11:05 and 20 seconds in the morning.

TIME 141830 <CR> ; Command to set the time to 2:18 and 30 seconds in the afternoon.
%05-DEC-97 14:18:30 E0 <CR> ; Status returned indicating that the date is December 5th '97, and the time is ; 2:18 and 30 seconds in the afternoon.

5.3.16 Software Version Command

VER <CR>

This command is used to determine the version of the RTU-292 firmware. The command requires no parameters.

Expected Response: Version Response.

Example:

VER <CR> ; Command sent to the RTU-292.
%VER 2.00 E0 <CR> ; Status returned from the RTU-292.

This status indicates that the CPU software version is 2.00.

5.4 STATUS RETURNED FROM THE RTU-292

The following section describes the various responses the user may expect from the RTU-292. The format of a response string is:

%response <data> <data> ... <data> Exx <CR>

There are 3 types of responses:

- **Synchronous**, the response is given as a result of receiving a specific command.
- **Asynchronous**, the response is given because of some change in operating status in the RTU-292 that was not directly due to a command being issued. In this case the RTU-292 simply volunteers this information without being asked for it.
- **Multi**, the response may be given as a result of a command being issued to the RTU-292 or because of a change in the RTU-292 operating status.

Each response always begins with a "%" synchronizing character. This is followed by a response "name" string. There is no space between the sync character and the response name. The response name identifies the information to follow. In the case of a Synchronous response, the response name is often the same as the previous command name. Any response data will follow the response name string. There is at least one space between each data section. Most data is presented in a specific order. The last data section is always the response error code. The error code takes the form "Exx" where "xx" is a number. The various error conditions are reflected in this number. The error response "E0" signifies that there were no errors. Finally the response string is terminated by a Carriage Return character.

Table 5-2 **Response Summary**

NULL Response	**% Exx <CR>**
Auto Answer Response	**%AUTO_ANS <ON|OFF> Exx <CR>**
Call Starting Response	**%Radio-Telephone Connection Made dd-MON-yy hh:mm:ss Exx <CR>**
Dial Response	**%DIAL <OPER|LP|number string> Exx <CR>**
Disconnect Response	**%DISC Exx <CR>**
DTMF Response	**%DTMF <number string> Exx <CR>**
Elapsed Time Response	**%Connection dropped, elapsed time: hh:mm:ss Exx <CR>**
Handset Phone Response	**%HS_PH <ON|OFF> Exx <CR>**
Handset Radio Response	**%HS_RAD <ON|OFF> Exx <CR>**
Speaker Radio Response	**%SPKR_RAD <ON|OFF> Exx <CR>**
Speed Dial Response	**%SD <nn> <num|"is empty."> Exx <CR>**
Tel-Line Phone Response	**%TEL_LINE_PH <ON|OFF> Exx <CR>**
Tel-Line Radio Response	**%TEL_LINE_RAD <ON|OFF> Exx <CR>**
Time/Date Response	**%dd-MON-yy hh:mm:ss <CR>**
Version Response	**%VER a.bb Exx <CR>**

Call Progress responses are listed in section 5.5.

Response error codes are outlined in section 5.6.

5.4.1 NULL Response

% Exx <CR>

Type: Synchronous.
Response To: NULL Command.

This response is given after receiving a NULL command. No data is returned in the response.

Example:
<CR> ; Command sent to the RTU-292.
% E0 <CR> ; Status returned from the RTU-292.

5.4.2 Auto Answer Response

%AUTO_ANS <ON|OFF> Exx <CR>

Type: Synchronous.
Response To: Auto Answer Command.

This response indicates the auto answering status.

Examples:
%AUTO_ANS ON E0 <CR> ; Status indicating that auto answering is enabled.
%AUTO_ANS OFF E0 <CR> ; Status returned indicating that auto answering is disabled.

5.4.3 Call Starting Response

%Radio-Telephone Connection Made dd-MON-yy hh:mm:ss Exx <CR>

Type: Asynchronous.
Response To: Start of a Radio/Telephone call.

This response indicates that a Radio/Telephone call has been started. The response shows the current time and date. The time is shown in 24-hour format. ***Note: the Call Logging Feature must be enabled before use. See 3.7.12.***

Examples:
Status indicating that a radio/telephone call has been started on January 10th '98 at 6:30 and 25 seconds in the morning.
%Radio-Telephone Connection Made 10-JAN-98 06:30:25 E0 <CR>

Status indicating that a radio/telephone call has been started on March 25th '99 at 2:30 and 25 seconds in the afternoon.
%Radio-Telephone Connection Made 25-MAR-99 14:30:25 E0 <CR>

The strings representing the month are:
JAN, FEB, MAR, APR, MAY, JUN, JLY, AUG, SEP, OCT, NOV, DEC

5.4.4 Dial Response

%DIAL <OPER|LP|number string> Exx <CR>

Type: Synchronous.
Response To: Dial Command.

This response indicates that the given number was dialed.

Valid digits for the number string are '0'-'9', the characters * # and ','. The comma character is used to produce a 2 second pause while dialing. No spaces are allowed in the number string.

Examples:

%DIAL 5551234 E0 <CR> ; Status returned indicating that the number 5551234 was dialed.
%DIAL OPER E0 <CR> ; Status returned indicating that the call has been placed to the operator (front panel).

5.4.5 Disconnect Response

%DISC Exx <CR>

Type: Multi.
Response To: Disconnect Command, Telephone Command (*#) Disconnect, System Initiated Disconnect

This response indicates that the PSTN, Operator, or Local Phone has been disconnected

Examples:

%DISC E0 <CR> ; Status returned indicating that the PSTN was disconnected.

5.4.6 DTMF Response

%DTMF <number string> Exx <CR>

Type: Synchronous.
Response To: DTMF Command.

This response indicates that DTMF was generated for the given number.

Valid digits for the number string are '0'-'9', the characters * # and ','. The comma character is used to produce a 2 second pause. No spaces are allowed in the number string.

Examples:
%DTMF 1234 E0 <CR> ; Status returned indicating that DTMF was generated for the number 1234.

%DTMF 1234 E6 <CR> ; Error status indicating that the unit could not generate DTMF at this time.
Most likely ; due to the fact the unit is still on-hook.

5.4.7 Elapsed Time Response

%Connection dropped, elapsed time: hh:mm:ss Exx <CR>

Type: Asynchronous.
Response To: Completion of a Radio/Telephone call.

This response indicates that a Radio/Telephone call has been terminated. The response shows the elapsed time of the call. The time is shown in 24-hour format. ***Note: the Call Logging Feature must be enabled before use. See 3.7.12.***

Examples:

Status indicating that a radio/telephone call has finished and the call lasted for 1 hour, 12 minutes, 34 seconds.
%Connection dropped, elapsed time: 01:12:34 E0 <CR>

Status indicating that a radio/telephone call has finished and the call lasted for 0 hours, 10 minutes, 25 seconds.
%Connection dropped, elapsed time: 00:10:25 E0 <CR>

5.4.8 Handset Phone Response

%HS_PH <ON|OFF> Exx <CR>

Type: Synchronous.
Response To: Handset Phone Command.

This response indicates the Handset Phone path status.

Examples:

%HS_PH ON E0 <CR> ; Status indicating that the Handset Phone path is enabled.
%HS_PH OFF E0 <CR> ; Status returned indicating that the Handset Phone path is disabled.

5.4.9 Handset Radio Response

%HS_RAD <ON|OFF> Exx <CR>

Type: Synchronous.
Response To: Handset Radio Command.

This response indicates the Handset Radio path status.

Examples:

%HS_RAD ON E0 <CR> ; Status indicating that the Handset Radio path is enabled.
%HS_RAD OFF E0 <CR> ; Status returned indicating that the Handset Radio path is disabled.

5.4.10 Speaker Phone Response

%SPKR_PH <ON|OFF> Exx <CR>

Type: Synchronous.
Response To: Speaker Phone Command.

This response indicates the Speaker Phone path status.

Examples:

%SPKR_PH ON E0 <CR> ; Status indicating that the Speaker Phone path is enabled.
%SPKR_PH OFF E0 <CR> ; Status returned indicating that the Speaker Phone path is disabled.

5.4.11 Speaker Radio Response

%SPKR_RAD <ON|OFF> Exx <CR>

Type: Synchronous.
Response To: Speaker Radio Command.

This response indicates the Speaker Radio path status.

Examples:

%SPKR_RAD ON E0 <CR> ; Status indicating that the Speaker Radio path is enabled.
%SPKR_RAD OFF E0 <CR> ; Status returned indicating that the Speaker Radio path is disabled.

5.4.12 Speed Dial Response

%SD <nn> <num|"is empty."> Exx <CR>

Type: Synchronous.
Response To: Speed Dial Command.

This response shows the contents of a given speed dial memory location.

Examples:

%SD 5 5551212 E0 <CR> ; Status indicating that speed dial location 5 contains the number 555-1212.
%SD 21 is empty. E0 <CR> ; Status indicating that speed dial location 21 is empty.

5.4.13 Tel-Line Phone Response

%TEL_LINE_PH <ON|OFF> Exx <CR>

Type: Synchronous.
Response To: Tel-Line Phone Command.

This response indicates the Tel-Line Phone path status.

Examples:

%TEL_LINE_PH ON E0 <CR> ; Status indicating that the Tel-Line Phone path is enabled.
%TEL_LINE_PH OFF E0 <CR> ; Status returned indicating that the Tel-Line Phone path is disabled.

5.4.14 Tel-Line Radio Response

%TEL_LINE_RAD <ON|OFF> Exx <CR>

Type: Synchronous.
Response To: Tel-Line Radio Command.

This response indicates the Tel-Line Radio path status.

Examples:

%TEL_LINE_RAD ON E0 <CR> ; Status indicating that the Tel-Line Radio path is enabled.
%TEL_LINE_RAD OFF E0 <CR> ; Status returned indicating that the Tel-Line Radio path is disabled.

5.4.15 Time/Date Response

%dd-MON-yy hh:mm:ss <CR>

Type: Synchronous.
Response To: TIME or DATE Command.

This response indicates the current Time and Date for the RTU-292 internal clock. ***Note: the Call Logging Feature must be enabled before use. See 3.7.12.***

Examples:
%01-MAR-98 11:05:20 <CR> ; Status returned indicating that the date is March 1st '98, and the time is ;11:05 and 20 seconds in the morning.

%05-DEC-97 14:18:30 <CR> ; Status returned indicating that the date is December 5th '97, and the time is ; 2:18 and 30 seconds in the afternoon.

The strings representing the month are:
JAN, FEB, MAR, APR, MAY, JUN, JLY, AUG, SEP, OCT, NOV, DEC

5.4.16 Version Response

%VER a.bb Exx <CR>

Type: Synchronous.
Response To: Version Command.

This response gives the RTU-292 firmware version data. The data is in the format "a.bb" where "a" is the major version (0-9), and "bb" is the minor version (00-99).

Example:

^ VER <CR> ; Command sent to the RTU-292 asking for the version data.
%VER 2.00 E0 <CR> ; Status returned from the RTU-292 showing version 2.00 with no errors.

5.5 CALL PROGRESS RESPONSES FROM THE RTU-292

The following section describes the responses the user may expect from the RTU-292 when Call Progress is active. Call progress is active whenever the PSTN is "off-hook".

Table 5-3 **Call Progress Responses**

%CP_RING Exx <CR>	Call Progress detects Ringback.
%CP_BUSY Exx <CR>	Call Progress detects a Busy signal.
%CP_NO_ANS Exx <CR>	No answer after the DIAL command originated a call.
%CP_NO_DIALTONE Exx <CR>	No dialtone when the DIAL command originated a call.
%CP_AUTO_ANSWERED Exx <CR>.	The RTU-292 has answered an incoming PSTN call

5.6 RESPONSE ERROR CODES

All responses from the RTU-292 include an error code. This error code allows the user to see if there were any problems with a given command. ***Unless otherwise noted the user may assume that a non-zero error code indicates that the command was not acted upon***.

Table 5-4 **Response Error Codes**

E0	No error.
E1	The previous command is unknown.
E2	The previous command was missing required parameter(s).
E3	The previous command had a parameter, which was out of the allowed range for this command.
E4	The previous command requested a resource, which is not available. An example of this would be a DIAL command sent to the Local Phone option, when the Local Phone option is not installed.
E5	The previous command requested a resource, which is currently busy. An example of this would be a DIAL command received when the RTU-292 is already off hook.
E6	The previous command may not be used at this time. An example of this would be a DTMF command received when the RTU-292 is still on-hook.
E7	A hardware related fault was detected.

6 Maintenance and Repair

6.1 GENERAL

Included in this section are the Test Procedures and performance evaluation criteria for the supplied equipment. Also provided is a Fault Analysis Table (Table 6.1) to aid in isolating a fault. Table 6.2 identifies replaceable parts.

6.2 PREVENTIVE MAINTENANCE

There are no preventive or periodic maintenance requirements for this equipment.

6.3 REPAIR OR REPLACEMENT

The repair or replacement of damaged and/or defective parts generally requires techniques that are standard in the industry. Carefully examine the equipment to determine the most correct and least time-consuming method required to make the repair.

6.3.1 GENERAL PRECAUTIONS AND NOTES

1. Disconnect power from the unit before attempting any repair or replacement of components.
2. Replace defective connectors only with identical items.
3. Carefully observe lead dress and component orientation when repairing circuits. Keep components leads as short as possible.
4. Reference to the component side of a printed circuit board denotes the side of the board on which the components are mounted. The solder or circuit side refers to the side opposite the components.

6.4 ALIGNMENT

No alignment is required or possible other than setting levels for the telephone line, receiver input and transmitter output which are done as a part of the normal equipment setup procedure.

6.5 PERFORMANCE TESTING

This section describes how to test and verify the basic performance of the RTU-292. Extensive test procedures pin-pointing the location of internal faults to the component level are beyond the scope of this manual.

6.5.1 TEST EQUIPMENT REQUIRED

1 ea. Audio Signal Generator, 600 Ohm Output

1 ea. Noise Generator or Radio Receiver
(See NOTE below)

1 ea. Audio Voltmeter, Hi-Z Input
(HP 400H or equivalent)

1 ea. Resistor, 560 Ohm to 680 Ohm, 1/4W min

6.5.2 HYBRID BALANCE MEASUREMENT

The test procedure outlined below allows measurement of the hybrid balance, or trans-hybrid loss, attainable with the RTU-292. This characteristic determines how much radio receiver input signal will leak into the transmitter output of the RTU-292. In the test set-up, the noise generator simulates the radio receiver, the audio voltmeter simulates the transmitter and the resistor simulates the telephone line. If the hybrid balance were perfect, the trans-hybrid loss would be and none of the receiver signal would leak into the transmitter (the audio voltmeter in this set-up would measure nothing except residual noise.)

The RTU-292 trans-hybrid loss specification is at least 30dB when measured with a noise source with an output bandwidth that matches the RTU-292's bandwidth. This means that the noise output measured by the audio voltmeter should be at least 30dB below the noise input to the RTU-292's hybrid. The test is performed with a 600 Ohm resistor simulating the phone line in order to have a repeatable standard impedance on which to base the specification. In actual use, the hybrid balance of the RTU-292 is excellent into impedances other than 600 Ohm (such as the complex impedances of the telephone lines) and is far better than any conventional hybrid under these conditions.

The procedure for this test using a noise generator is listed in paragraph 6.5.2.1. If a noise generator is not available, the alternate test method that employs an audio signal generator (see paragraph 6.5.2.2) may be used. Figure 6.1 shows equipment interconnections necessary to perform this test.

NOTE

The accuracy of the trans-hybrid loss measurement depends on the bandwidth of the noise generator used to perform the test. It is possible, however, to achieve an evaluation of the unit to within a few dB tolerance without a commercial noise generator by using the audio output of an SSB or AM receiver that has no antenna connected. This type of receiver with a 2.5 to 3.5 kHz SSB IF bandwidth makes an ideal noise generator for this measurement because the output noise is band limited by the receiver's IF filters. (FM receivers, however, have too wide a noise bandwidth and will produce erroneous results using this procedure.) The receiver's noise output should be between -20dBm and 0dBm so that the RTU-292 can be adjusted for the correct hybrid input level.

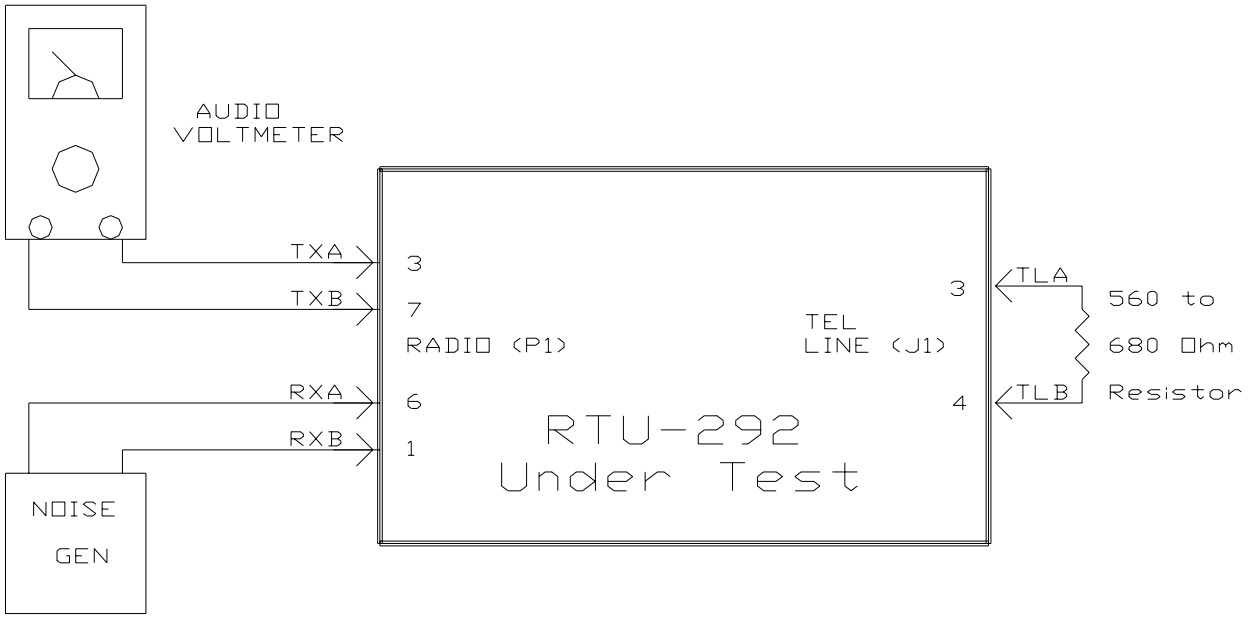

Figure 6-1 Hybrid Balance Test Set-Up

6.5.2.1 Main Hybrid Test Procedure

1. Disconnect the RTU-292 from all other equipment and connect the test equipment as shown in Figure 6.1.

2. Set the PSTN levels for -9 dBm using Option SW2-1, -2, and -3.

3. Start with the following pushbuttons OFF: TEL LINE/PHONE, TEL LINE/RADIO, and TEL VOX. The positions of the other buttons are unimportant. Place the RTU-292 in set-up mode by setting SW2-7 ON and then turning on the power. (See paragraph 2.10.1 for further details about set-up mode.)

4. Adjust the TX Level Adjust, R133, so that the audio voltmeter reads -6dBm (0.387V rms). This sets the transmit signal output path in the RTU-292 for unity gain if the input level is correctly set.

5. Adjust the RX Level Adjust, R116, so that the PEAK LED flashes rapidly and is on about 50% of the time. (This is different from the instructions in paragraph 2.10.3, which set the RX Level Adjust for voice)

6. Remove the unit from Set-up Mode by turning the RTU-292 Main Power OFF, setting SW2-7 OFF, and then turning the main power back ON.

7. Push the TEL LINE/RADIO button to start the adaptation cycle.

8. When the initial adaptation cycle is complete, the noise output can be read on the audio voltmeter. The voltage should be less than -37dBm (10.9 mV). The trans-hybrid loss is the difference between this reading and the approximate -7 dBm noise level.

6.5.2.2 Alternate Hybrid Test Procedure

This alternate test procedure uses a more easily obtainable audio signal generator in place of the noise generator. While this procedure cannot give a complete picture of the unit's performance in actual use, it will allow a determination of whether or not the RTU-292 is operating properly.

1. Disconnect the RTU-292 from all other equipment and connect the test equipment as shown in Figure 6.1, except use an audio signal generator in place of the noise generator.

2. . Set the PSTN levels for -9 dBm using Option SW2-1, -2, and -3.

3. Start with the following pushbuttons OFF: TEL LINE/PHONE, TEL LINE/RADIO, and TEL VOX. The positions of the other buttons are unimportant. Place the RTU-292 in set-up mode by setting SW2-7 ON and then turning on the power. (See paragraph 2.10.1 for further details about set-up mode.)

4. Adjust the TX Level Adjust, R133, so that the audio voltmeter reads -6dBm (0.387V rms). This sets the transmit signal output path in the RTU-292 for unity gain.

5. Set the output amplitude of the audio signal generator to about 0dBm (0.775V rms). Adjust the RX Level Adjust so that the PEAK LED just comes on. This will set the average noise level into the RTU-292's hybrid to approximately 0dBm.

6. Remove the unit from Set-up Mode by turning the RTU-292 Main Power OFF, setting SW2-7 OFF, and then turning the main power back ON.

7. Set the audio generator frequency to about 1 kHz.

8. Push the TEL LINE/RADIO button to start the adaptation cycle.

9. When the initial adaptation cycle is complete, the tone output can be read on the audio voltmeter. The voltage should be typically less than -50dBm (2.5mV). The trans-hybrid loss is the difference between this reading and the approximate 0dBm tone level.

NOTE

The reading should be made as soon as the adaptation cycle is complete. The RTU-292 continuously adapts itself to the conditions to which it is exposed. With the single tone input presented by this test, the unit will eventually adapt to reject only this single tone instead of the intended broad range of frequencies. This may take several seconds to several minutes, and an erroneous reading will result when this happens. The reading will always be correct (and an accurate depiction of operation under normal conditions) immediately following the initial adaptation cycle, since the unit has adapted broad band using its own noise source, and has not yet had time to adapt to the single tone only.

10. To measure the unit at a different frequency, change the audio generator frequency and repeat steps 8 and 9.

6.5.3 VOX SENSITIVITY MEASUREMENT

The following test procedure measure the sensitivity of the VOX in the RTU-292. This is the amplitude of the incoming signal from the telephone line required to trigger the VOX.

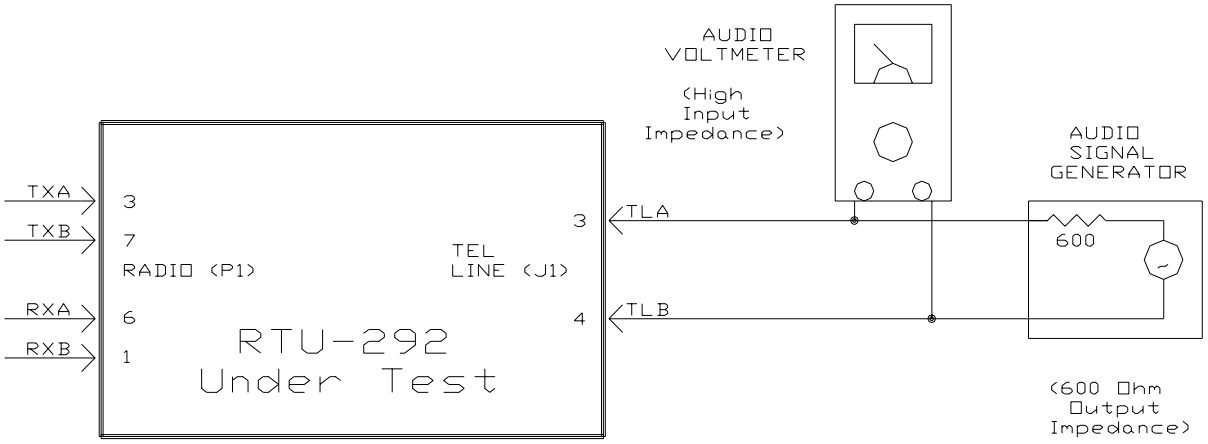

Figure 6-2 VOX Sensitivity Test Set-Up

6.5.3.1 VOX Test Procedure

1. Disconnect the RTU-292 from all other equipment and connect the test equipment as shown on Figure 6.2.

2. The PSTN level setting must be known. To determine this, remove the top cover and note the positions of SW2-1, -2, and -3.

3. Start with the following pushbuttons OFF: TEL LINE/PHONE and TEL LINE/RADIO. Push the TEL VOX button ON. The positions of the other buttons are unimportant.

4. Set the audio signal generator frequency to 1 kHz with an output amplitude of less than -40dBm (7.7mV rms).

5. Push the TEL LINE/RADIO button to start the adaptation cycle.

6. When the initial adaptation cycle is complete, slowly increase the audio generator amplitude until the Keyed LED on the RTU-292 comes on. The audio generator amplitude at this point (read directly by the audio voltmeter) is the VOX sensitivity. The VOX trip point is dependent on the setting of the PSTN levels and the VOX sensitivity setting. It should be 16 $\pm$ 2 dB below the PSTN setting as listed in the table below:

VOX Sensitivity	VOX Trip Point
MAX	19 $\pm$ 2 dB below the PSTN setting
MED	16 $\pm$ 2 dB below the PSTN setting
LOW	13 $\pm$ 2 dB below the PSTN setting
MIN	10 $\pm$ 2 dB below the PSTN setting

Table 6-1 Fault Analysis	
No LEDs light after power-up	Check for correct setting of DC voltage switch S6. Check for proper polarity of DC input. (If polarity is reversed, the unit will not be damaged, but will not operate.
At power-up, the PEAK LED flashes at a steady rate and the unit does not function properly.	The RTU-292 has failed its self-test function. Check for proper seating of the internal DSP module. Contact JPS Customer Service.
At power-up, POWER LED is lighted, but dim. Unit does not function.	DC Voltage selector switch S6 set to default +24/28 VDC setting, but input voltage is +12V.
The PEAK LED never flashes on radio receiver audio.	The TEL LINE/RADIO button must be ON for the PEAK LED to function. or Audio input from the receiver is set too low. Adjust RX Input potentiometer R116 fully CW for maximum input. If LED still does not flash on audio peaks, check receiver audio connections. If using unbalanced input, be sure that remaining balanced audio terminal is grounded. See 2.10 for audio adjust procedures.
The PEAK LED is on nearly continuously.	Excessive audio level from the radio receiver. Adjust R116, the RX Input potentiometer, CCW. If LED still flashes too often after R116 is fully CCW, lower audio level at receiver. See 2.10 for audio adjust procedures.
The TEL-LINE/RADIO LED flashes for more than three seconds after the TEL-LINE/PHONE button is pushed.	The RTU-292 is having difficulty during initial adaptation cycle. Probable noise, conversation, dial tone, or busy signal on the phone line while the unit is trying to adapt.
The TEL-LINE/RADIO LED flashes for more than ten seconds after the TEL-LINE/PHONE button is pushed.	The RTU-292 was not able to complete its initial adaptation cycle. Probable extreme noise, dial tone, busy signal, or other type of signal present on the phone line. Be certain that a good telephone connection is obtained before pushing the TEL LINE/PHONE button.
The VOX does not function.	The VOX is disabled while the TEL-LINE/RADIO is not ON. The VOX is disallowed if the unit has not been able to adapt.
VOX false triggers on audio peaks from the receiver.	Excessive audio level from the receiver or overdrive of the phone line. If the PEAK LED is flashing normally on receiver voice peaks (see 2.10), check the setting of the telephone send and receive levels. Also, extremely bad phone line is possible.

Table 6-2 Replaceable Parts List

5970501000 Chassis Assembly

Part No.	*Description*	*Reference Designator*
153080001	Speaker, 8 ohm, 3" sq	LS1
360003001	Conn, MTA-156, 3-pin, receptacle	For P4
362005001	Conn, circular, pnl mt receptacle	J1
362007000	Conn, cable, 7-pin, AMP	P8, Keypad conn
362008000	Conn, cable, 8-pin. AMP	P9, P12, P16
370002001	Conn, barrier strip, 2 position	J2 (Rear Panel DC Input)
632000010	AC Filter and Fuseholder Assy	
810811800	Handle, .25 x 1.25 x 2.75 mtg ctr	
1110250002	Knob, blk w/dot, .250ID	Spkr, phones
1610501102	Pot, 5K, lin, 1/4", panel mount	Spkr, phones
1940120086	Keypad, Molded Legend, 3 x 4	
1946220001	Sw, lock toggle, DPDT, 6A, Silver	S1 (Power switch)
5962102000	DSP Module, Pcb Assembly	Surface mt. pcb

5930302800 Telephone Line Switch Assembly

Part No.	*Description*	*Reference Designator*
320220250	Cap, elect, 22uF, 25VDC	C5
327104101	Cap, mylar, 0.1uF, 10%, 100V	C1,2,4
364010101	Conn, Header, .125bd, 10pin, retain	J1
1221062201	LED, rt angle pc mnt, green	CR1,CR2
1221062202	LED, rt angle pc mnt, Yel	CR4
1943000003	Sw, push, mom, 30VDC, .4A	Sw1,2,3,4

5930302700 Handset Switch Assembly

Part No.	*Description*	*Reference Designator*
320220250	Cap, elect, 22uF, 25VDC	C5
327104101	Cap, mylar, 0.1uF, 10%, 100V	C1,2,4
364010101	Conn, Header, .125bd, 10pin, retain	J1
1221062202	LED, rt angle pc mnt, Yel	CR1-4
1820271000	Resistor, carb, 1/4w, 270 ohm	R1-4
1943000003	Sw, push, mom, 30VDC, .4A	SW1-4

5930302500 Speaker Switch Assembly

Part No.	*Description*	*Reference Designator*
320220250	Cap, elect, 22uF, 25VDC	C5
327104101	Cap, mylar, 0.1uF, 10%, 100V	C1,2,4
364010101	Conn, Header, .125bd, 10pin, retain	J1
1221062200	LED, rt angle pc mnt, Red	CR3,4
1221062202	LED, rt angle pc mnt, Yel	CR1,2
1820271000	Resistor, carb, 1/4w, 270 ohm	R1,2,3,4
1943000003	Sw, push, mom, 30VDC, .4A	SW1,2,4

Programmed Ics

Part No.	*Description*	*Reference Designator*
934272XXX	IC, dig, 27C256 32kx8 EPROM	U40 (main bd XXX is rev#)
6934029XXX	IC, dig, 29C010	U8 (DSP Module XXX is rev#)

5970506100 RTU-292 Main PCB Assembly

Part No.	*Description*	*Reference Designator*
320010500	Cap, elect, 1uF, 50VDC	C103
320020500	Cap, elect, 2.2uF, 50VDC	C3,29,35,125
320100500	Cap, elect, 10uF, 50VDC	C91
320101250	Cap, elect, 100uF, 25VDC	C21,33,42,80,124,126
320101500	Cap, elect, 100uF, 50VDC	C112
320102350	Cap, elect, 1000uF, 35VDC	C43,44
320152160	Cap, elect, 1500uF, 16VDC	C128
320220250	Cap, elect, 22uF, 25VDC	C96,97,113,115,117,119,123
320220250	Cap, elect, 22uF, 25VDC	C34,62,63,65,67,68,69,74,95
320220250	Cap, elect, 22uF, 25VDC	C10,11,13,14,15,22,25,26,27,32
320272350	Cap, elect, 2700uF, 35VDC	C120,121
323100102	Cap, disc cer, 10pF, 5%, NPO, 100V	C92,93
323470102	Cap, disc cer, 47pF, NPO, 100V	C31
327102101	Cap, mylar, 1nF, 10%, 100V	C4-7,24,37,38,39,41,46,47,59,64
327103101	Cap, mylar, 0.01uF, 10%, 100V	C1,20,23,61,66,70,81,85,107,108
327104101	Cap, mylar, 0.1uF, 10%, 100V	C8,9,28,30,40,45,60,71,72,73
327104101	Cap, mylar, 0.1uF, 10%, 100V	C75-78,82,84,90,94,98-102,109
327104101	Cap, mylar, 0.1uF, 10%, 100V	C122,130-155,159-168
327105100	Cap, mylar, 1 uF, 10%, 100V	C2
327474101	Cap, mylar, 0.47uF, 10%, 100V	C83,110,111,114,116,118,127,129
327474401	Cap, mylar, 0.47uF, 10%, 400V	C12
327682101	Cap, mylar, 0.0068uF, 10%, 100V	C87
328332500	Cap, poly, 3.3nf, 50V	C36,86
364003100	Conn, Header, 3-pin single row	JP1,JP2,JP3
364004100	Conn, Header, 4-pin single row	J11
364007100	Conn, Header, 7-pin, single row	J5
364010101	Conn, Header, .125bd, 10pin, retain	J19 (to Options)
364016101	Conn, Header, Male, 16 Pin retain	J10,J18,J20
364040101	Conn, Header, .125, 40 pin, retain	J15
364040104	Conn, header, 20x2, 0.250 spc, male	J13,J14
365003102	Conn, 3-pin w/notches, .156 center	J4
365004100	Conn, pcb, 4 x 1 friction lock	J22
365007100	Conn, Header, 7-pin friction lock	J8
365008100	Conn, PCB, 8 x 1, friction lock	J6,J9,J12,J16
365010101	Conn, header, MTA-156, 10-pin	J3
367009100	Conn, DB9, shielded male, pc mount	P1,2
370002000	Conn, misc, 2-pin jumper	JP1-3,J5,J11
370006000	Conn, RJ11C Modular Jack, pc mount	J1,J21
370006002	Conn, RJ12C, Mod. Jack, PC mt	J7
380035800	Crystal, 3.579545 MHz	Y1,Y2
380080000	Crystal, 8.000 MHz	Y3
420000060	Diode, Bridge, 600V, 1A	CR1
420001040	Diode, Bridge, 20 PIV, 400 VW, 3A	CR36
423058180	Diode, Schottky, 1N5818, 1A, 30V	CR30,32-35,38,39,40
426040040	Diode, rect, 1N4004, 400V, 1A	CR4,7,8,9
428041480	Diode, Signal, 1N4148	CR12-16,20-23,37
430062670	Diode, trans sup, 1N6267, 6.8V, 5W	CR2,3
432052540	Diode, Zener, 1N5254, 27V	CR5,6
432053590	Diode, Zener, 1N5359B, 24V	CR31
870504100	Heatsink, T0-220, black, 0.85 high	For U70-72,Q24
910103000	Inductor, molded, small, 10uH, 5%	L3,4,5
910223000	Inductor, molded, small, 22uH, 5%	L1,2,6
912101001	Inductor, pwr, 100uH, large	L7,8,9
920000200	Insulator pad, for crystal	For Y1,2,3
920537700	Insulator, silpad	For U73
931074040	IC, dig, 74HC04N, hex inverter	U10,48
931074923	IC, dig, MM74C923N, 20 key encoder	U59
931743740	IC, dig, 74HC374N, Oct D FF, 3-stat	U38,50-53,62,63
933074000	IC, dig, 74HC00N, quad NAND	U24,47,65,66

5970506100 RTU-292 Main PCB Assembly (continued)

Part No.	*Description*	*Reference Designator*
933074154	IC, dig, 74HC154N, 4:16 decoder	U43,44
933074244	IC, dig, 74HC244N, 3-state driver	U54-57,60,61
933074373	IC, dig, 74HC373N, octal d latch	U39,58
933741390	IC, dig, 74HC139, 2-4 Decoder	U42
935681101	IC, dig, 68HC11A0FN w/o EEPROM	U46
936074742	IC, dig, 74ALS74N, Dual D FF, Adv.	U64
939016430	IC, dig, DS1643-150, real time cloc	U41
950020020	IC, lnr, TDA2002V, 8W audio amp	U17
953118100	IC, lnr, LT1181CN 5V RS-232 xcvr	U37
953145436	IC, lnr, MC145436, DTMF RCVR	U25
954000820	IC, op amp, TL082CP, dual biFET	U1-3,13,15,16,20,21
956005550	IC, Timer, NE555	U30,31,32
958010720	IC, V reg, LT1072CT, Switching Reg	U73
958078050	IC, V.reg, MC7805ACT, 5VDC	U71,72
958078120	IC, V.reg, MC7812ACT, 12VDC	U70
959002120	IC, lnr, DG212CJ Quad Analog Gate	U4,5,6,8,9,18,19,22,23,33
959005720	IC, lnr, NE572N, Dual Compandor	U14
959043500	IC, lnr, 4N35, 6-pin Opto isolator	U7,11,12
959077051	IC, lnr, TL7705ACP, V superv	U45
1221062200	LED, rt angle pc mnt, Red	CR24
1610102000	Pot, 1K, single turn, trimpot, pcb	R212
1611502000	Pot, 25 turn, 5K, vert pc	R156,158
1611503000	Pot, 25 turn, 50K, vert pc	R116,133
1810012014	Relay, low pwr, DPDT, 12VDC	K1,K2
1820000000	Resistor, carb, 1/4W, 0 ohm	R131,168,171,176
1820010000	Resistor, carb, 1/4w, 1 ohm	R15,16,94
1820100000	Resistor, carb, 1/4w, 10 ohm	R14,92
1820101000	Resistor, carb, 1/4w, 100 ohm	R59,63,98,175
1820102000	Resistor, carb, 1/4w, 1000 ohm	R50,51,52,95,97
1820103000	Resistor, carb, 1/4w, 10K ohm	R185-192,197,198,211
1820103000	Resistor, carb, 1/4w, 10K ohm	R119,136,141,146,165,166,180
1820103000	Resistor, carb, 1/4w, 10K ohm	R7,10,11,12,17,18,21,32,41,42
1820104000	Resistor, carb, 1/4w, 100K ohm	R137-139,142,152,157,161-164
1820104000	Resistor, carb, 1/4w, 100K ohm	R20,23,25,27,36,72,74,76,77
1820104000	Resistor, carb, 1/4w, 100K ohm	R78,80,82,84,85.86,89123-127
1820105000	Resistor, carb, 1/4w, 1Meg ohm	R56,88,145,170
1820124000	Resistor, carb, 1/4w, 120K ohm	R151
1820132000	Resistor, carb, 1/4w, 1300 ohm	R211
1820152000	Resistor, carb, 1/4w, 1500 ohm	R115,132
1820153000	Resistor, carb, 1/4w, 15K ohm	R8,55,57,58,62,210
1820183000	Resistor, carb, 1/4w, 18K ohm	R2,4,37,38,39,40
1820202000	Resistor, carb, 1/4w, 2000 ohm	R200
1820204000	Resistor, carb, 1/4w, 200K ohm	R73,81,154
1820221000	Resistor, carb, 1/4w, 220 ohm	R91,93
1820222000	Resistor, carb, 1/4w, 2200 ohm	R61,65,90,140,150,153,160
1820223000	Resistor, carb, 1/4w, 22K ohm	R13,19,24,33,64,66,70,71
1820223000	Resistor, carb, 1/4w, 22K ohm	R79,118,120,121,128-130,144
1820392000	Resistor, carb, 1/4W, 3900 ohm	R110
1820470000	Resistor, carb, 1/4w, 47 ohm	R202
1820471000	Resistor, carb, 1/4w, 470 ohm	R99,167,208
1820472000	Resistor, carb, 1/4w, 4700 ohm	R6,9,26,53,60,96,117,134,155
1820472000	Resistor, carb, 1/4w, 4700 ohm	R159,172-174,179,201,209
1820473000	Resistor, carb, 1/4w, 47K ohm	R113,143,182,183,193-196
1820473000	Resistor, carb, 1/4w, 47K ohm	R30,31,35,75,83,87,100,111
1820512000	Resistor, carb, 1/4w, 5100 ohm	R122
1820513000	Resistor, carb, 1/4w, 51K ohm	R114
1820561000	Resistor, carb, 1/4w, 560 ohm	R1,34,112,135
1820621000	Resistor, carb, 1/4w, 620 ohm	R67,68,69
1820682000	Resistor, carb, 1/4w, 6800 ohm	R22,54

5970506100 **RTU-292 Main PCB Assembly (continued)**

Part No.	*Description*	*Reference Designator*
1820912000	Resistor, carb, 1/4w, 9100 ohm	R3,5,28,29
1821102000	Resistor, carb, 1/2w, 1000 ohm	R207
1826020000	Resistor, Varistor, RMS200V	RV1
1827400050	Resistor, ww, 5W, 40 ohm	R203,204,205,206
1828759030	Resistor, pwr ox, 3W, 7.5 ohm	R213,214
1829101040	Resistor Pack, 9x100K, 10 pin SIP	RP1,2,3,4
1920280000	Socket, IC, non-ret tin, 28p WDIP	For U40
1920520000	Socket, IC, non-ret, 52 pin PLCC	For U46
1941008000	Sw, pcb, SPSTx8, dip	SW1,SW2
1944020001	Sw, slide, DPDT, 6A @ 125VAC	S6
2020016001	Xfmr, audio, 1:1, min.	T1,T2,T3
2021334000	Xfmr, Pwr, 115/230 VAC, 34 VAC @ 700mA	T4
2040080200	Xstr, bipolar, darl, MJE 802, NPN	Q1,24
2043041240	Xstr, bipolar, sml sig, 2N4124, NPN	Q2
2047070000	Xstr, Fet, n-channel, 2N7000	Q3-8,Q10-23,25,26

7 RTU-292 Options

7.1 GENERAL

Included in this section are installation instructions for field installable RTU-292 options and set-up instructions for all options that have configuration dipswitches, jumpers, potentiometers, etc. Operational instructions are provided for all options other than the Voice Prompt Option; this frequently used options is explained along with standard unit operation in section 3. JPS may be able to install a software option by connecting with your existing RTU-292 via telephone; request this service when ordering. Spares kits and the 19" Rack Mount Kit are listed in section 1.

7.1.1 Special Software Versions

The options listed in the section may or may not be installable in an RTU-292 that has special software created by JPS to fit a non-standard application. If your RTU-292 has special software, consult JPS customer service before ordering options.

Table 7-1 RTU-292 Options

Item	*JPS P/N*	*Description*
Hardware Options		
Local Phone Option	5930-596000	Allows remote operation of the RTU-292 through the use of a standard telephone set connected directly to the RTU-292 Local Phone port. (Telephone set and cable not supplied.)
DTMF Telephone Set	5930-599000	Telephone set for use with the Local Phone Option
Voice Prompt Option	5930-595000	Standard Version (English, female voice)
VMM-100 Option	5930-591100	Provides DSP Voice Modulation Recognition squelch and/or DSP Noise Reduction to the radio RX input.
STU-III Option	5960-796000	Allows connection to a STU-III phone
Software Options		
Call Logging S/W Option	5970-791500	Provides record of calls via RS-232 interface.
Radio Control Option	5970-795000	Provides remote control of URC-200 radio via RS-232 int.
Squelch Break Access Option	5970-791300	Allows radio access to the RTU-292 via a series of squelch breaks
DTMF Access Option	5970-799000	Allows radio access and control via the radio's DTMF keypad.

7.2 VOICE PROMPT OPTION

When the Voice Prompt Option is installed, the RTU-292 will send helpful prompts to system users to guide them in proper system operation and inform them of the current system status. The standard language is female English, though other languages and genders may be purchased, an additional fee to create the non-standard prompts is charged. Contact JPS for details.

7.2.1 INSTALLATION AND CONFIGURATION

The Voice Prompt Option is a small PCB that is installed to four threaded standoffs in the options tray, with a 20-wire cable from the option to connector J7 on the Options Interface board, which is also installed in the options tray. Figure 7.1 shows correct option placement in the options tray.

After the Voice Prompt option is installed, the main CPU must be informed by switching on the Voice Prompts Enable dipswitch, SW1-6 on the Main Board. Remember that this switch is only read at unit power-up. No other configuration settings or adjustments are required.

Table 7-2 ***Voice Prompts Enable***

SW1-6	Voice Prompts
Off	Disabled
On	Enabled

7.2.2 OPERATION

Since the Voice Prompt Option is very commonly used, its operational instructions are included in section 3, RTU-292 Operation. Theory of Operation information is included in section 4.

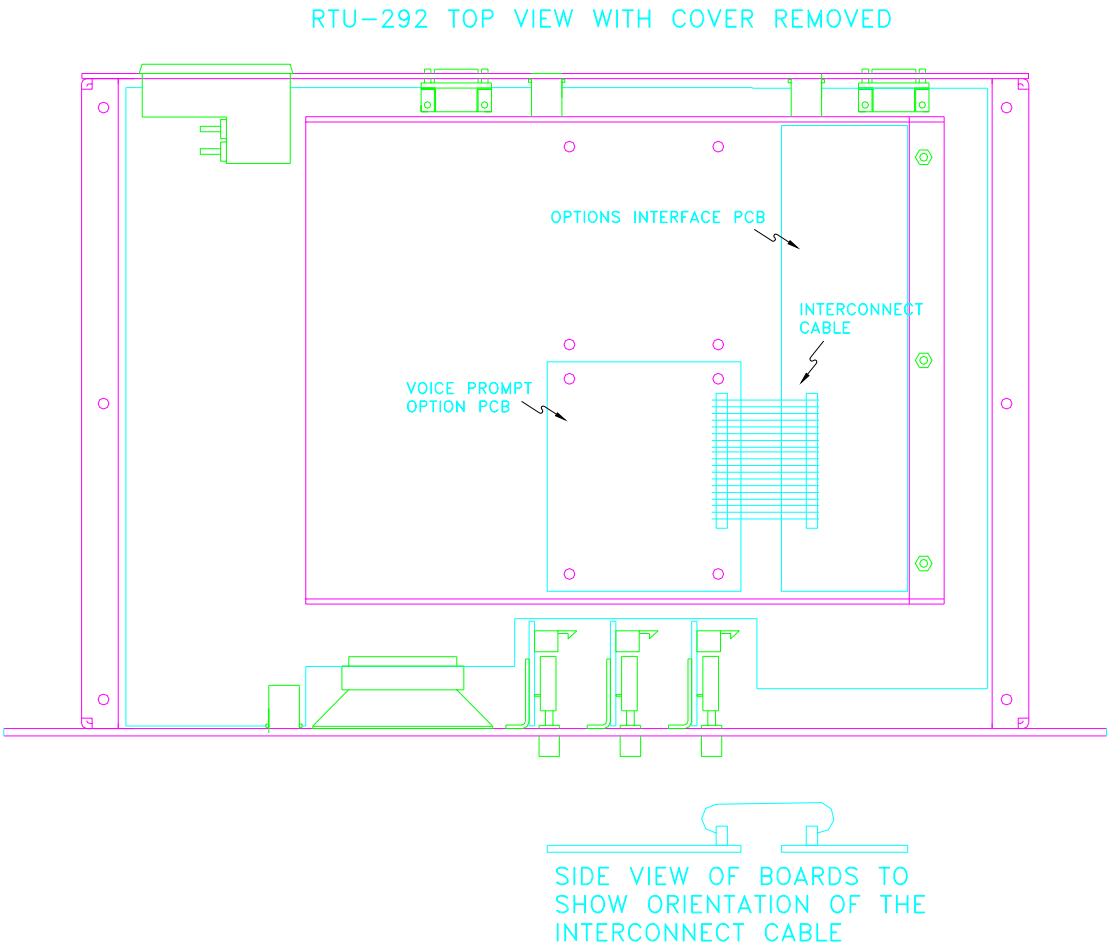

Figure 7-1 Voice Prompt Option Installation

7.3 LOCAL PHONE OPTION

The RTU-292 has an extra rear panel modular phone jack that allows a standard DTMF telephone set to be plugged directly into the unit when the Local Phone Option is installed. This Local Phone set can make and receive calls via the outside line, communicate with an operator at the RTU-292, or send and receive audio through the companion radio. It can also be used to program the RTU-292. The Local Phone Option consists of a small Printed Circuit Board assembly that is installed in the RTU-292 options tray. Theory of Operation information is included in section 4.

7.3.1 LOCAL PHONE OPTION INSTALLATION AND CONFIGURATION

The Local Phone Option is a small PCB that is installed to four threaded standoffs in the options tray, with a ribbon cable assembly that runs from the option to connector J20 on the Main Board. Figure 7.2 shows correct option placement in the options tray. The telephone set and interconnect cable to the telephone set are not included with the option.

After the Local Phone Option is installed, the main CPU must be informed by switching on the Local Phone Enable dipswitch, SW1-7, on the Main Board. Remember that these switches are only read at unit power-up. SW1-7 must be left off when the option is not installed. SW1-8 enables the Local Phone Ring-Through feature. This causes the local phone to ring whenever a call is received by the RTU-292 via the PSTN input. When ring-through is disabled, the local phone may still be used to send and receive calls, but will not ring when a call is received. Set SW1-8 to On to enable Local Phone Ring-Through, and Off to disable this feature. This switch should always be set to Off (disabled) when the Local Phone Option is not installed.

Table 7-3 **Local Phone Enable**

SW1-7	Local Phone
Off	Disabled
On	Enabled

Table 7-4 **Local Phone Ringthrough**

SW1-8	Ringthrough
Off	Disabled
On	Enabled

7.3.2 LOCAL PHONE OPTION OPERATION

When the handset of the local phone is picked up, a special dial tone, generated by the RTU-292, will be heard in its receiver. The user then has three options:

Table 7-5 **Local Phone DTMF Commands**

DTMF Command	Function
0	Place a call to the RTU-292 Operator
1	Connect radio audio to the local phone
9	Place telephone calls to the outside PSTN line

Once the local phone user has selected a function and entered the associated DTMF character, he may use any of the keypad commands that are available to a PSTN caller in the command mode (see Table 3-1). It is important to note that the local phone audio into the RTU-292 does not run through the unit's DSP circuitry and therefore cannot activate the VOX function. Always de-activate the VOX function and use the manual key/unkey commands when communicating over a radio via the local phone (see telephone commands in 3.7.3.4).

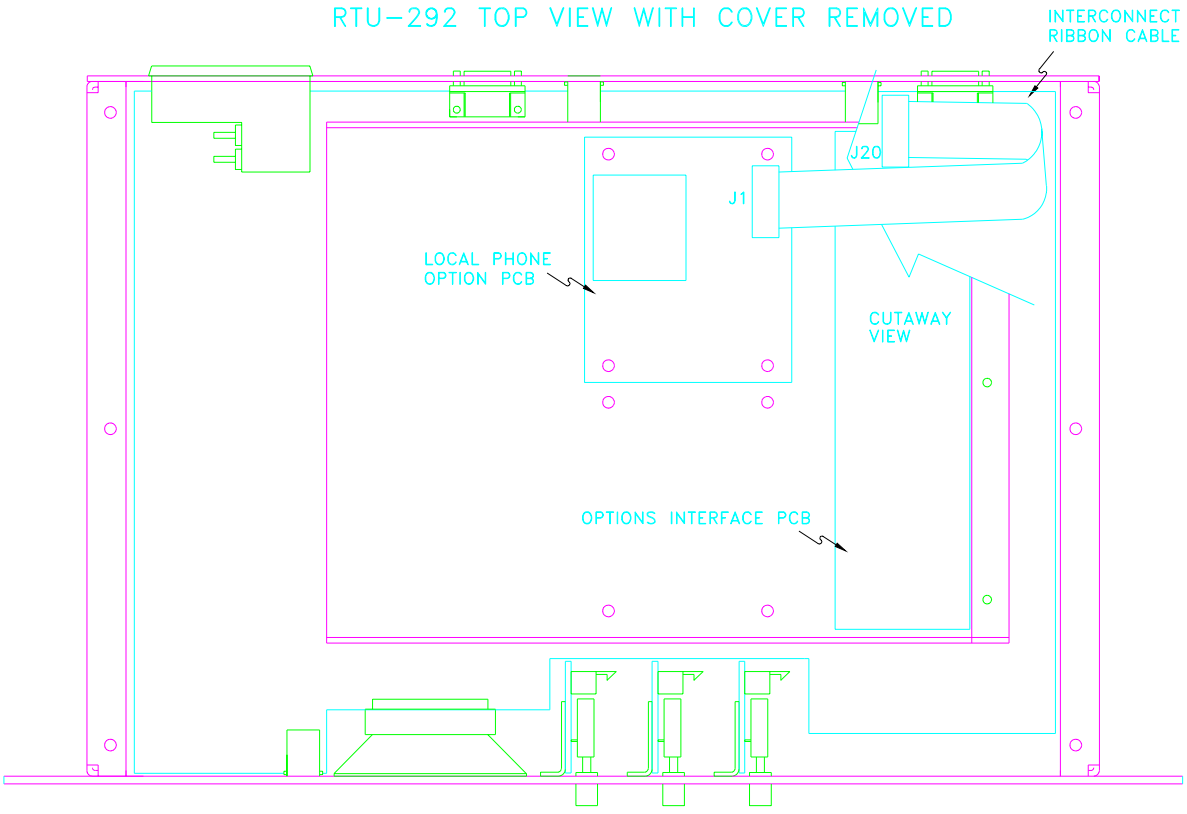

Figure 7-2 Local Phone Option Installation

7.4 VMM-100 OPTION

The VMM-100 VMR Module implements Voice Modulation Recognition (VMR) which enables the receive audio path when speech is present and disables it when speech is not present. This module also implements a form of noise reduction known as "dynamic peaking" which reduces background white noise. These features are implemented with a DSP circuit on the VMM board.

7.4.1 VMM-100 Hardware

The general purpose of the DSP hardware is to convert analog audio signals to the digital domain, operate on and manipulate these signals digitally, then convert the result back to analog.

7.4.1.1 VMM-100 DSP Section

The heart of the DSP section is the DSP chip itself, a TMS320C25. The unit runs at 40 MHz and produces a 5 MHz signal at the U1-58 CLKOUT, which supplies timing to PEEL U3 and ultimately to U2, the Analog Interface Chip. U2 then supplies an interrupt to the 320C25 approximately every 130 microseconds, which establishes the sample rate of about 8 kHz. The DSP operating program is contained in EPROM chips U5 and U6. Two chips provide the necessary 16-bit-wide architecture; the high byte is contained in U5 and the low byte in U6.

Static RAM chips U9 and U10 are used for temporary data storage during operation of the program.

All of the "glue" logic necessary to interface the DSP with the various peripheral chips on the board is provided by PEEL (Programmable Electrically Erasable Logic) U3.

U8 is a reset generator that insures an orderly power-up sequence for the DSP and associated components. It senses the voltage on the +5V line and generates a reset while the voltage is below approximately 4.55V. As the voltage rises above the threshold, a delay is generated by C8 to insure processor clock stability before operation commences. Resistor R2 prevents U8 from resetting on short spikes on the 5V line.

Latch U4 provides an eight-bit parallel output from the DSP. Two of the outputs are used (NR3 and NR4), while the other six are spare. Latch U12 provides an eight-bit parallel input to the DSP. Two of the inputs are used (NR1 and NR2), while the other six are spare. Latch U11 provides a means for the DSP to read SW1 switch settings.

7.4.1.2 VMM-100 Analog Interface

Chip U2 provides the analog interface to the DSP section. This chip is type TLC32040 and contains an A/D converter for the analog input, D/A converter for analog output, and an anti-alias filter before the A/D, and a reconstruction filter after the D/A. The chip derives its own timing for these functions from the master clock provided by the DSP. These chips are interfaced to the DSP via a serial bus.

Amplifier U13 is a dual op-amp that provides gain-of-one buffer amplifiers for the analog audio input and output.

7.4.2 VMM-100 Software

The VMM-100 DSP software can provide voice modulation recognition, noise reduction, or both. The module's operating mode is set by logic inputs at P9 pins 3 and 4

7.4.2.1 VMR Algorithm

The VMR algorithm works by passing the audio through a series of bandpass filters that are spaced throughout the speech frequency spectrum. The outputs of these filters are then examined for signals with speech characteristics. If speech is detected, the audio path is enabled and the LED is lit. The VMR threshold is set by SW1 switches 3 & 4. This threshold is not volume related; it specifies how stringent the VMR algorithm is when deciding whether a signal contains speech. The correct setting will depend on many aspects of the incoming signal and the requirements of the user. A lower threshold setting increases the likelihood that a signal, which is comparable to speech, but does not actually contain speech, will be passed through. A higher threshold will eliminate these false detections, but will increase the possibility that a signal, which contains speech that is strongly masked by noise, will not be detected.. The default setting should be good for most signals.

The audio output is delayed, allowing speech to be detected before audio arrives, so that no syllables are missed. SW1 switches 7 & 8 set the duration of the delay. There is also an adjustable "Hang-Time", which keeps the audio path enabled for an adjustable length of time after the instant when speech is no longer detected. This hang-time prevents the disabling of the audio path between syllables or during pauses in speech. SW1 switches 5 & 6 set the hang-time duration.

7.4.2.2 Noise Reduction Algorithm

The noise reduction algorithm operates by passing the audio through an adaptive FIR (Finite Impulse Response) filter. The filter forms instantaneous bandpass filters around the relatively correlated information contained in speech, these filters are not created around non-correlated white noise, causing it to be suppressed.

7.4.3 VMM-100 INSTALLATION AND CONFIGURATION

The VMM-100 is installed in the options tray opposite from the Options Interface Board. The holes required for installation are included on the tray, but standoffs are not permanently installed as this precludes the installation of other options at this location. See Figure 7-3. Install the board with 6 screws, standoffs, lock washers, and nuts. Install the screws from the bottom side of the tray. A cable tie-down is also supplied, and the VMM-100 option connector is assembled to the 10 pin Noise Reduction Connector, J5, on the Options Interface Board.

To set up the VMM-100, place the separate switches of eight-position dipswitch SW1 per system requirements. The LED on the board can be used to easily set the correct receive audio level, which is necessary for optimal operation of the VMR and Noise Reduction Modes. This LED normally indicates when speech has been detected, but when the VMR function is turned off, this LED becomes a signal level indicator, and will flash on voice peaks when the correct volume of speech containing signal is present. To use this LED to adjust the volume of the audio input, turn the VMR function off (see Table 3-1) and inject speech at a normal speaking level into the module's audio input. Adjust the input volume until the LED lights occasionally on voice peaks.

The dipswitches on the VMM-100 module may be changed at any time during operation; the DSP is constantly checking the states of these switches. The VMR and Noise Reduction modes can be used individually or simultaneously. They are toggled off & on via standard DTMF Operational Commands. See section 3.7 and Table 3-1.

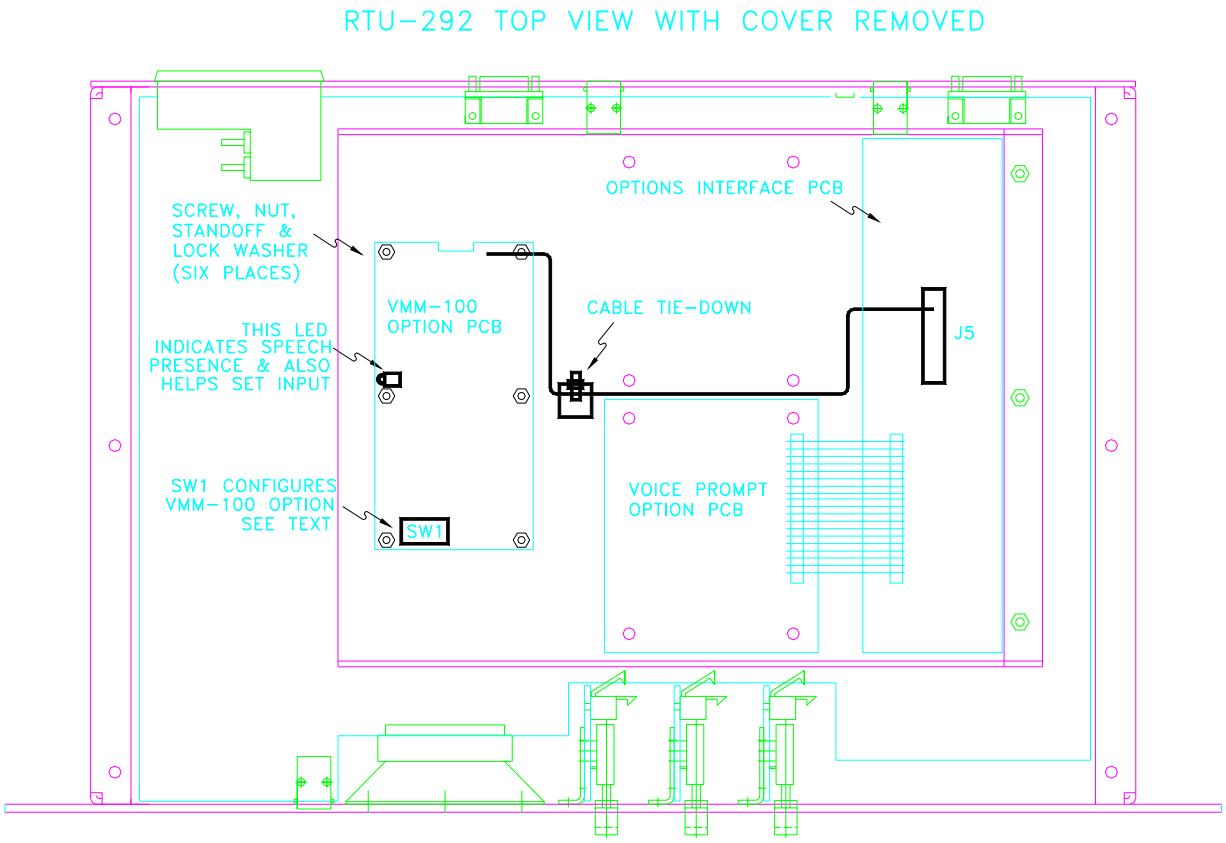

Figure 7-3 VMM-100 Option Installation

Table 7-6 VMM-100 SPECIFICATIONS	
GENERAL	
Frequency Response	100 to 3400 Hz +/- 2dB
Input Level	0 dBm nominal
Input Impedance	Unbalanced 10k Ohm
DSP Output Delay	< 10mS
Noise Reduction Type	Dynamic Peaking around coherent signals
Noise Reduction	Approximately 10-20 dB
Audio Output	10 Ohm unbalanced, 0 dBm nominal
Audio Output Distortion	Less than 0.5% @ 1 kHz
VMR Performance	Probability of detection (Pd) > 95% at 0 dB S/N ratio
VMR Output Delay	0-300 ms, adjustable
VMR Hang Time	0.75-2.25 sec, adjustable in half-second increments
Indicators	Audio Level/Speech Present LED
Size	5.75" x 3.0" printed circuit board
Power Requirements	+5 VDC, 200 mA nominal
	+12 VDC, 5 mA nominal
	-5 VDC, 20 mA nominal
ENVIRONMENTAL	
Operating Temperature	-20C to +55C
Storage Temperature	-40C to +85C
Humidity	Up to 95% @ +55C
Shock	MIL-STD-810D, method 516.3 procedure VI
Vibration	MIL-STD-810D, method 514.3 Category I
Altitude	Up to 10,000 ft.

Table 7-7 VMM-100 I/O CONNECTOR INFORMATION (P9)	
Pin	**Signal**
1	Audio Input (see specs above)
2	Audio Output (see specs above)
3	NR1; Logic Input; Low selects DSP Noise Reduction
4	NR2; Logic Input; Low selects DSP Voice Modulation Recognition
5	-5V; Supply Input (see specs above)
6	+5V; Supply Input (see specs above)
7	+12V; Supply Input (see specs above)
8	NR3; Logic Output; Follows state of SW1-1; Low indicates default is NR on
9	NR4; Logic Output; Follows state of SW1-2; Low indicates default is VMR on
10	Ground

Table 7-8 VMM-100 Switch Functions		
SW1-1 FUNCTIONS		
SW1-1,2	For future use; leave off	
SW1-3, 4 FUNCTIONS		
SW1-3	**SW1-4**	**Threshold**
On	On	1 (lowest)
Off	On	2 Factory Default
On	Off	3
Off	Off	4 (highest)
SW1-5, 6 FUNCTIONS		
SW1-5	**SW1-6**	**Hangtime**
On	On	0.75 seconds
Off	On	1.25 Factory Default
On	Off	1.75
Off	Off	2.25
SW1-7, 8 FUNCTIONS		
SW1-7	**SW1-8**	**Delay**
On	On	0 msec
Off	On	100 Factory Default
On	Off	200
Off	Off	300

7.5 DTMF ACCESS OPTION

This option allows a radio user to use his DTMF keypad to quickly place a telephone call via the RTU-292. If the user does not have DTMF capability, the Squelch Break Access Option allows the use a series of squelch breaks to automatically connect to the telephone at speed dial location #01 (see next section). In the following description, system voice prompts are listed. If the Voice Prompt Option is not installed, only the tone prompts will be heard.

NOTE

It is possible to enable this option remotely. If you have purchased an RTU-292 without this option and want to add it, contact JPS.

7.5.1 Initiate Call Via Attention Signal

The radio user sends the "Attention" signal to the RTU-292. The attention signal consists of the DTMF characters "*** * ***" (three stars).

7.5.2 RTU-292 Response to Attention Signal

The RTU-292 will respond with the voice prompt "*RTU-292 automatic phone patch. Enter phone number followed by the "pound" sign or stand by for auto-call*". The RTU-292 will also give the Acknowledge (ACK) tones. If Password Protection is enabled, the RTU-292 will request the correct password prior to asking for the telephone number.

7.5.3 Radio Caller Provides Calling Directions

The radio user can then enter a phone number (terminated by the # sign), or "* n n #" for speed dial location "nn". If the caller forgets to enter "#" the RTU-292 will simply wait 4 seconds to ensure that data entry is complete and then begin to place the call. If no DTMF is detected at the RTU-292, the unit will place a call to the telephone at the speed dial location #01. This is an "auto-call".

7.5.4 RTU-292 Plays Back Phone Number & Prompts for Confirmation

The RTU-292 will play back the number it intends to dial. In the case of speed dial numbers, it only plays back the speed dial location and not the number stored at that location. The RTU-292 then prompts the caller for confirmation with the prompt "*Please confirm by entering a single "Star" digit*", along with the Query tone prompt. If the RTU-292 does not receive confirmation within five seconds, it will give a Timeout prompt and go back to its waiting state.

7.5.5 RTU-292 Places the Call

The RTU-292 then informs the radio user that the call is being placed. The ringback information that is provided when placing a call via the RTU-292 front panel keypad or Local Phone is not sent over the air due to FCC regulations. The RTU-292 adapts to the phone line while placing the call.

If the number is busy, the busy tones will be broadcast for approximately 5 seconds before the RTU-292 terminates the call attempt.

Once the RTU-292 detects ringback, the RTU-292 begins a 30 second timer and waits for the call to be answered. If this does not happen before the timer expires, the call attempt is terminated.

7.5.6 After the Call Begins

The RTU-292 now enters its "Command Mode", meaning that the phone user may enter any of the available DTMF commands from Table 3-1. The Inactivity Timer will now begin to run. If this time expires (due to a lack of speech or other audio activity), the RTU-292 will give a series of 3 short beeps as a warning. The radio caller or the phone user may initiate activity within 5 seconds of the warning beeps to reset the timer. If neither user does so, the unit will then terminate the call.

To terminate the call at any time, the radio user may enter *** #** at any time. The phone user may also enter *** #** to hang up.

7.6 SQUELCH BREAK ACCESS OPTION

This option allows a radio user who does not have DTMF capability to quickly place a telephone call via the RTU-292. The radio user simply transmits a series of squelch breaks and is then automatically connected to the telephone at the RTU-292 speed dial location #01. To use the squelch break feature, the local radio's squelch output must be connected to the RTU-292 /External Signal Input, and the RTU-292 continuously monitors this line for the correct squelch break timing. The RTU-292 will respond to either a positive going or negative-going squelch signal.

NOTE

It is possible to enable this option remotely. If you have purchased an RTU-292 without this option and want to add it, contact JPS.

7.6.1 Initiate Call Via Attention Signal

The radio user sends the "Attention" signal to the RTU-292. This is a series of 3 squelch breaks that occur within 4 seconds window.

7.6.2 RTU-292 Response to Attention Signal

The RTU-292 will respond with the voice prompt "*RTU-292 automatic phone patch"*. The Acknowledge (ACK) Tone prompt is also given.

7.6.3 RTU-292 Prompts for Confirmation

The RTU-292 then requests confirmation with the prompt "*Please confirm with a single squelch break*". The caller confirms his desire to call by giving 1 additional short squelch break within 5 seconds. If the RTU-292 does not receive confirmation within that time, it will give a "Timeout" tone prompt, terminate the attempt to call, and go back to its waiting state.

7.6.4 RTU-292 Places the Call

The RTU-292 then informs the radio user that the call is being placed. The ringback information that is provided when placing a call via the RTU-292 front panel keypad or Local Phone is not sent over the air due to FCC regulations. The RTU-292 adapts to the phone line while placing the call.

If the number is busy, the busy tones will be broadcast for approximately 5 seconds before the RTU-292 terminates the call attempt.

Once the RTU-292 detects ringback, the RTU-292 begins a 30 second timer and waits for the call to be answered. If this does not happen before the timer expires, the call attempt is terminated.

7.6.5 After the Call Begins

The call can now proceed, and the Inactivity Timer will now begin to run. If this time expires (because no speech or other activity is heard), the RTU-292 will give a series of 3 short beeps

as a warning. The radio caller or the phone user may initiate activity within 5 seconds of the warning beeps to reset the timer. If neither user does so, the unit will then terminate the call.

To terminate the call at any time, the radio user may enter * # or give three squelch breaks within four seconds. The phone user may enter * # to hang up.

7.7 THE CALL LOGGING OPTION

The RTU-292 contains a Real Time Clock (RTC) IC that allows the logging outgoing telephone calls via the unit's RS-232 serial communications port. Full information regarding the use of this port is provided in section 5. The factory default setting disables Call Logging. To enable, enter the programming mode by the DTMF sequence *** 9 9,** then enter *** 0 1**. Finally, enter * # to leave the programming mode. See Tables 3-1 and 3-2.

NOTE

It is possible to enable this option remotely. If you have purchased an RTU-292 without this option and want to add it, contact JPS.

7.7.1 Checking The Time And Date

Check both the time and the date by simply entering the remote control command **TIME** with no parameters. The time and date that the RTC is set to will be returned. If not correct, set as explained below. The RTC keeps track of leap years but not daylight savings time.

7.7.2 Setting The Time

Enter the command **TIME hhmmss** where **hh** is the hour (00-23), **mm** signifies the minutes (00-59), and **ss** gives the current seconds (00-59).

7.7.3 Setting The Date

Enter the command **DATE ddmmyy** where **dd** is the current date (01-31), **mm** is the month (01-12), and **yy** is the last two digits of the year (00-99).

7.7.4 Call Logging

Enable and disable call logging by entering as described above. Once call logging is enabled, whenever a radio-to-telephone connection is made, a message is sent via RS-232 noting the beginning of the call and indicating the starting time and date.

When the connection is terminated, another message is sent indicating the time and date and also listing the elapsed time of the call. The elapsed time is provided in the format hh:mm:ss. The elapsed time provided will be incorrect if any single radio-to-telephone connection exceeds 24 hours.

7.8 RADIO CONTROL OPTION

When this software option is enabled, the RTU-292 may be used to control a Motorola URC-200 radio connected to the unit via the RS-232 serial port. The control commands may be entered by the RTU-292 front panel keypad, or by the keypad of a connected telephone or by a telephone set wired to the Local Phone Option. To use front panel keypad control, the LINE-PHONE and LINE-RADIO pushbuttons must both be off. See 7.7.1 for special instructions regarding the use of the front panel keypad to send DTMF Commands.

The user must press either the HANDSET-PHONE or HANDSET SPEAKER pushbuttons in order to hear the accompanying voice prompts.

The unit cannot be put into the DTMF Radio Command Mode unless dipswitch SW1-3 is turned on. The DTMF Radio Command Mode must then be initiated via the * 8 Operational Command before these DTMF Commands can be executed. (See Table 3-1.)

When a command has been entered, the RTU-292 will acknowledge the command with a tone prompt. If an incorrect command is issued the unit plays the ERROR tone and gives the "Invalid Entry" voice prompt. If the command is correct, but the data is out of range the unit plays the ERROR tone and gives the "Data Was Not Accepted By The Radio" prompt. Whenever a valid command is entered, the unit will play back the radio's setting after the command is sent to the radio. Note that this feature is only available if the Voice Prompt option is installed. Consult the URC-200 manual for further information regarding the command descriptions.

NOTE

It is possible to enable this option remotely. If you have purchased an RTU-292 without this option and want to add it, contact JPS.

7.8.1 CONTROLLING THE RADIO VIA THE RTU-292 FRONT PANEL KEYPAD

When a Motorola URC-200 radio connected to the RTU-292 is programmed or controlled by the RTU-292 via front panel (rather than a connected telephone or the Local Phone Option), the following special instructions must be heeded. When using the front panel for radio control, the operator uses the handset and keypad.

To begin front panel control the user must enter three "*" keypresses. The RTU-292 will respond with an Acknowledge tone prompt and the voice prompt "*READY*". At this point all front panel keypad entries are treated just as though the user were sending commands via the telephone or local phone.

Front panel control operation will continue until one of the following conditions occurs:

- The user enters a "*#" sequence.
- There is neither PTT activity nor keypad activity for the duration of the activity timer.

While the operator is using the keypad to control the RTU-292, the unit will not be available for:

- PSTN Auto Answering.
- Radio Squelch Break Access Operation.
- Radio DTMF Access Operation.
- Local Phone Control.

Table 7-9 DTMF Radio Control Commands

These commands are intended to control a Motorola URC-200 radio associated with the RTU-292. The Radio Control Option must be enabled (See Table 1-2).

Command	Followed By	Command Description
* 0	[0..9]	Channel (preset) select
* 1	[nnnnn]	Frequency Select (both receive and transmit)
* 2	[nnnnn]	Transmit frequency select
* 3	[0..1]	Scan mode (0 = scan stop, 1 = scan start)
* 4		Reserved for future use
* 5	[000..255]	Squelch select
* 6	[0..1]	Text mode select (0 = plain text, 1 = cipher text)
* 7	[0..1]	Modulation select (0 = AM, 1 = FM)
* 8	[0..2]	Power level select (0 = low, 1 = med, 2 = high)
* 9 9	Saves the current radio channel (preset) data.	
* #	Leave Radio Command Mode (may be entered at any time).	

With all of the above commands (except *3, *99, and *#), the user may substitute the DTMF "#" character in place of the "Followed By" data to query the radio for its current setting. For example, if the sequence "*** 0 1**" is entered, the RTU-292 will command to the radio to select channel 1. However if the sequence "*** 0 #**" is entered, the RTU-292 will play back the current channel number. (The Voice Prompt Option is required to take advantage of this playback feature.)

8 SCHEMATIC DIAGRAMS

8.1 GENERAL

This section has all RTU-292 schematic diagrams. They include:

Figure 8-1 Front Panel Schematic

A single sheet showing the switch boards and other front panel components.

Figure 8-2 Main Board Schematic

This nine page schematic details all components on the main board. Notes are included to differentiate the schematic when the board used in different JPS products, the RTU-292, the RTU-300 (desktop version), and the RTU-285 (special application version- not for general sale). There are two different power supply schematics. On the eighth page is the schematic for the power supply configuration used with the RTU-292 or RTU-300. The ninth page is the power supply configuration for the RTU-285 only.

Figure 8-3 DSP Module

The DSP Module that plugs into the Main Board via a pair of in-line 20-pin headers has two schematic pages.

Figure 8-4 Option Interface Board

This is a single-sheet schematic for the narrow PCB that resides in the side of the options tray and provides an interface between the various standard option boars and the main PCB.

Figure 8-5 Voice Prompt Option Board

Figure 8-6 Local Phone Option Board

Figure 8-7 VMM-100 Option Board

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